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Ljubljana, SLOVENIA

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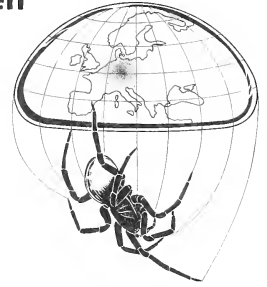
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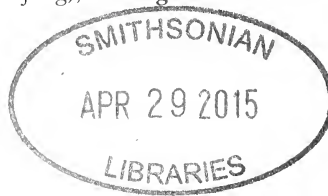
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Karlsruhe, Juni 2013

Preface to the section of the Proceedings of the 27th European Congress of Arachnology, Ljubljana, 2012 Sept. 2-7 (pp. 4-20)

doi: 10.5431/aramit4501

Almost four years ago, during the 2009 congress in Greece, I was called away from the Russian party only to be cornered by the esteemed colleagues of the ESA council and be asked the unnerving question, to which, of course, a negative response was not an option: "Matjaž, how would you feel about organizing a future European congress"? Three years later, in September 2012, not only European arachnologists, but also many overseas col-

leagues came to Ljubljana with huge expectations from me and my crowd of enthusiastic, yet inexperienced, sidekicks, of which only one was a professional researcher, and the rest were graduate or undergraduate students. 2012 was a recession year, and with hundreds of our letters asking for sponsorship of this "unique and prestigious scientific event" ignored (though with a handful of exceptions, see below), we had to pull the event off on a shoestring. We did, however, keep the fees low for numerous colleagues to be able to attend, and in addition we sponsored an unprecedented number of students that would otherwise be unable to attend the meeting; no fewer than 30 lucky international students were thus awarded grants that in addition to waived fees also covered their accommodation.

And so we (EZ lab) hosted, at the Scientific Research Centre of the Slovenian Academy of Sciences and Arts (ZRC SAZU) in Ljubljana, between 2nd and 7th September 2012, 156 colleagues from 39 countries. The participants represented most European countries, and those from further afield came from Brazil, Uruguay, Mexico, USA, Algeria, India, Pakistan, Japan, China, Taiwan, Singapore and Australia. As people told us, the congress was a lot of fun.

The event would never have been possible without the amazing help from my EZ Lab



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organizing team. Thank you Matjaž Gregorič, Ren-Chung Cheng, Nina Vidergar, Klemen Čandek, Urška Pristovšek and Miha Pipan, who made the impossible things work, with further help coming from Olga Kardoš, Martin Turjak, Tea Knapič, Klavdija Suen and selected student grantees. I am also indebted to the wonderful scientific committee, Drs. Simona Kralj-Fišer, Ingi Agnarsson, Christian Kropf, Daiqin Li and Miquel Arnedo. These colleagues helped me select and invite four outstanding plenary speakers from around the World. We were privileged to welcome and listen to the lectures of Jason Bond (Auburn University, USA) on integrative approaches to delimiting species and taxonomy, Fiona Cross (University of Canterbury, New Zealand) on olfaction based behaviour of a mosquito-eating, and thus blood-sucking, jumping spider from Africa, Eileen Hebets (University of Nebraska, USA) on interacting traits and secret senses in arachnids, proposing them as model organisms in studying behavioural evolution and Fritz Vollrath (University of Oxford, UK), who spoke of the secrets of silk. These lectures were all fascinating and of high scientific value. Most of them can be viewed online at http://videlectures.net/eca2012_ljubljana/.

We grouped the presentations into logical sessions, some of which had to be parallel, with

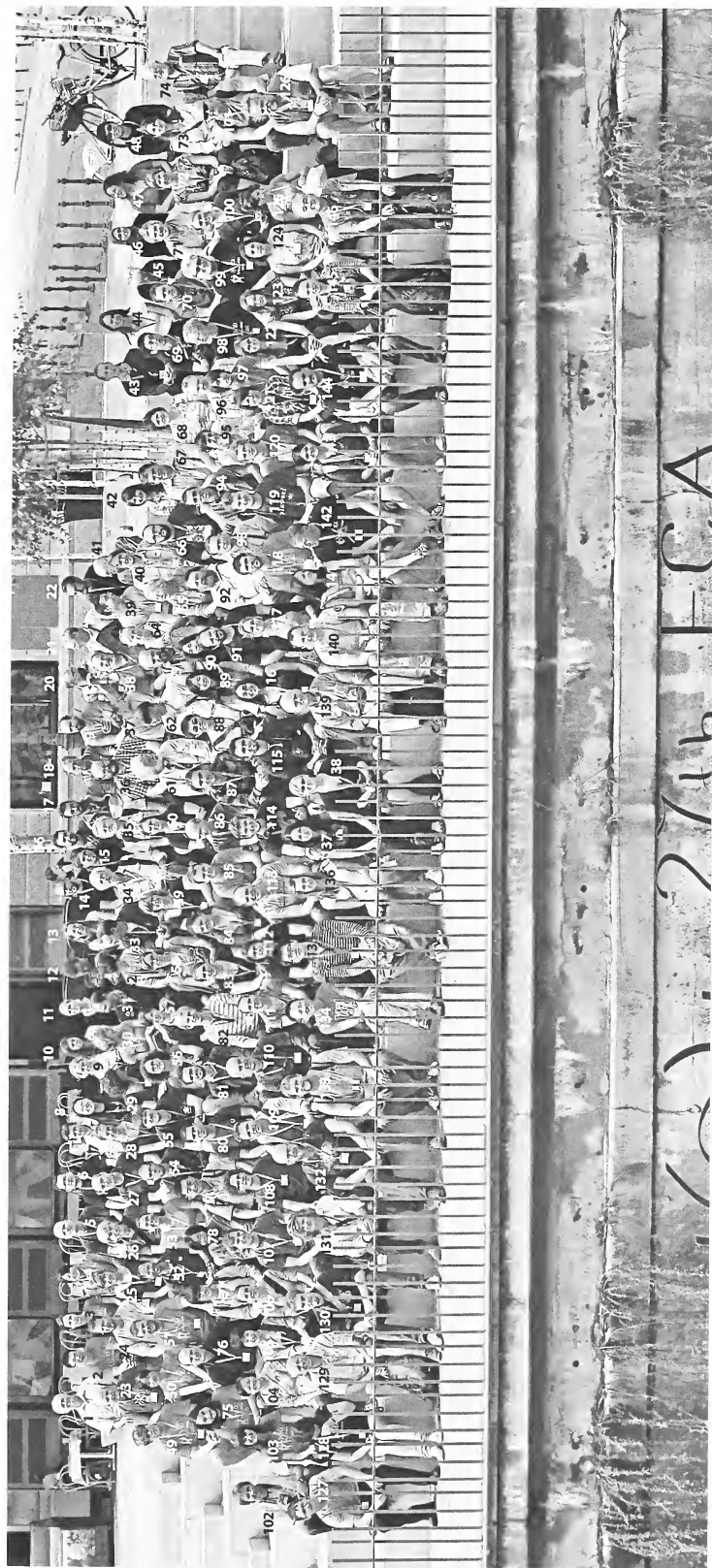
non-overlapping presentations of the students competing for awards. With the help of Wolfgang Nentwig we also organized a symposium on DNA barcoding, where longer introductory talks by Miquel Arnedo, Ingi Agnarsson and Jeremy Miller introduced the concepts and recent practices in discovering, delimiting and inventorying species using DNA barcodes, while more specific presentations introduced recent European barcoding initiatives. There were also two poster sessions, and many social events. We congratulate again those students who won awards, kindly provided by our sponsors, although the selection amongst many high quality student presentations was difficult. Within the broad category "Systematics and Evolution", the awarded oral presentations were those of Henrik Krehenwinkel (1), Elisabeth Lipke (2) and Marija Majer (3), the awarded posters were those of Jana Plíšková (1), Susanne Meese (2) and Cheng-Ya Chang (3). Within the category "Ecology and Behavior" the awards for oral presentations went to Katrin Kunz (1), Shazia Quasin (2) and Reiner Neumann (3), while those for posters went to Urška Pristovšek (1), Hsien-Chun Liao (2) and Klaas Welke (3).

The main congress sponsors in addition to the European Society of Arachnology were the Scientific Research Centre of the Slovenian

Academy of Sciences and Arts (<http://www.zrc-sazu.si/>) and its EZ Lab (<http://ezlab.zrc-sazu.si/>), the Slovenian Academy of Sciences and Arts (<http://www.sazu.si/en/o-sazu.html>) and the Slovenian Research Agency (<http://www.arrs.gov.si/en/dobrodoslica.asp>). Further generous sponsorships came from Pensoft (<http://www.pensoft.net/>), Bioform (<https://www.bioform.de/>), the British Arachnological Society (<http://britishspiders.org.uk/>), the American Arachnological Society (<http://americanarachnology.org/>) and the Arachnologische Gesellschaft (<http://arages.de/>).

Finally, although the congress saw numerous talks and posters (the Abstract book can be downloaded at <http://ezlab.zrc-sazu.si/eca2012#abstracts>), the future of the proceedings from the European Congress of Arachnology may be bleak, as no more than five manuscripts in total were submitted from the Ljubljana congress, of which three withstood peer review and were evaluated as appropriate for publication. Perhaps it's time for the society to reconsider the future of publishing presentations from the congresses in manuscript form, but rather move towards publishing and indexing only presentation abstracts.

Matjaž Kuntner, Ljubljana



1 Paul Selden - 2 Ren-Chung Cheng - 3 Nina Videgar - 4 Seok Ping Goh - 5 Ingi Agnarsson - 6 Shichang Zhang - 7 Roman Bucher - 8 Tingting Zhang - 9 Susanne Meese - 10 Liana Lasut - 11 Leila Gurtner - 12 Christian Kropf - 13 Fiona Cross - 14 Holger Frick - 15 Ivan Franco - 16 Alberto Chiarle - 17 Mauro Paschetta - 18 Giulio Gardini - 19 František Štáhlavský - 20 Dmitri Logunov - 21 Boris Zakharov - 22 Marco Isala - 23 Theo Blick - 24 Arnaud Heniard - 25 Charlotte De Busschere - 26 Robert Bosmans - 27 Wolfgang Merten - 28 Jasmin Ruch - 29 Gabriele Uhl - 30 Hannah Wood - 31 Jeremy Miller - 32 Eileen Hebets - 33 Jason Bond - 34 Jakob Walter - 35 Wolfgang Nentwig - 36 Kjetil Åkra - 37 Ludmila Černecká - 38 Plamen Mitov - 39 Christoph Muster - 40 Mikhail Omelko - 41 Christo Deltchev - 42 Olena Yaroshynska - 43 Jonas Wolff - 44 Sara Goodacre - 45 Yael Lubin - 46 Huda Al-Beiruti - 47 Efrat Gavish-Regev - 48 Pao-Shen Huang - 49 Miha Pipan - 50 Xin Xu - 51 Matjaž Gregorič - 52 Daiqin Li - 53 Simona Krall-Fiser - 54 Gergely Ambrus - 55 Peter Michalik - 56 Jutta Schneider - 57 Katrin Kunz - 58 Eileen Gabel - 59 Annedore Maeder - 60 Cristina Rheims - 61 Fritz Vollrath - 62 Stano Pekár - 63 Yuri Marusik - 64 Irina Marusik - 65 Elisabeth Baughenß - 66 Alessio Trotta - 67 Peter Gajdoš - 68 Nina Polchaninova - 69 Samuel Yu-Lung Hsieh - 70 Miguel Richard - 71 Miquel Arnedo - 72 Vera Opatová - 73 Mariia Fedoriak - 74 Jörg Wunderlich - 75 Klemen Candek - 76 Matjaž Kuntner - 77 Wen-Jin Gan - 78 Yueh-Sheng Loong - 79 I-Min Tso - 80 Youcef Alioua - 81 Majid Moradmand - 82 Gregor Wachter - 83 Petra Föttinger - 84 Miriam Schalder - 85 Pavel Just - 86 Petr Dolejš - 87 Ondřej Košulič - 88 Chih-Wei Lai - 89 Cheng Ya Chang - 90 Yun-Jia Lo - 91 Vladimir Hula - 92 Seppo Koponen - 93 Pavel Žila - 94 Manuel Cárdenas Guerrero - 95 Jan Raška - 96 Henrik Krehenwinkel - 97 Radek Michalko - 98 Siegfried Huber - 99 Peter Horak - 100 Gordana Grbić - 101 Günther Raspočnik - 102 Christian Komposch - 103 Urška Pristovšek - 104 Ning Sun - 105 Lihong Tu - 106 Stefanie Zimmer - 107 Klaas Welke - 108 Rainer Neumann - 109 André Walter - 110 Bernhard Huber - 111 Elisabeth Lipke - 112 Jens Runge - 113 Andy Sombke - 114 Bastian-Jesper Klufsmann-Fricke - 115 Alejandro Valdez Mondragón - 116 Ivalú H. Avila - 117 Jana Niedobová - 118 Jagoba Malumbres Olarte - 119 Stanislav Korenko - 120 Anna Šestáková - 121 Wioletta Wawer - 122 Lenka Sentenská - 123 Eva Liznarová - 124 Laura Montes de Oca - 125 Helga Helling - 126 Csaba Szinetár - 127 Alexandr Anatolevich Fomichev - 128 Anna Nekhaeva - 129 Ferenc Samu - 130 András Rákóczi - 131 Dakota Piorkowski - 132 Heine Kiesbüh - 133 Sean Kelly - 134 Chen-Pan Liao - 135 Hsien-Chun Liao - 136 Jana Kotrbová - 137 Jana Plíšková - 138 Hana Svojanovská - 139 Peter van Helsing - 140 Marjan Komnenov - 141 Alexandra Lazarova - 142 Sroyan Lazarov - 143 Shazia Quasin - 144 Atul Bodkhe - 145 Nataša Sivec - 146 Hirotsugu Ono

On the identity of the poorly known spider species *Zelotes strandi* (Araneae: Gnaphosidae)

Christo Deltchev

doi: 10.5431/aramit4502

Abstract. The taxonomic status and distribution of the poorly known gnaphosid species *Zelotes strandi* (Nosek, 1905) is clarified, discussed and mapped on the basis of both the holotype (a single female from Turkey) and newly collected material (males and females from Bulgaria). This species was originally described from the island of Prinkipo (= Büyükada, District of Istanbul, Turkey) and the holotype is currently housed in the Naturhistorisches Museum, Vienna. Both sexes are here diagnosed and illustrated, whereby the male is described for the first time.

Keywords: Bulgaria, first description of male, new records, taxonomy, Turkey

Nosek (1905) described 23 new spider species from the families Dysderidae, Theridiidae, Lycosidae, Agelenidae, Gnaphosidae and Thomisidae collected by the well-known Austrian naturalist Arnold Penther in different regions of Turkey, including the Island Prinkipo (= Büyükada) in the Marmara Sea, near Istanbul. From the material collected in the territory of this island, Nosek described the species *Zelotes strandi* (Nosek, 1905) (originally in *Prosthesima*) on the basis of a single female specimen. Since its original description, there have been no further records concerning the taxonomy and distribution of the species (Chatzaki 2010, Senglet 2011, 2012, Platnick 2013). Having had the opportunity to examine the collection of A. Nosek kept in the Vienna Museum – and comparing it with material collected from different regions of Bulgaria – it became possible to provide a description of the previously unknown male together with a redescription of the female based on new drawings and photos.

Material and methods

The type material (a single female) was studied and photographed, without removing the epigyne. The spider material from Bulgaria was collected by hand and by pitfall traps from various localities (Fig. 1). The map of the Balkan Peninsula follows Abadjiev (2001). Measurements of the legs were taken from the dorsal side. Total body length includes chelice-

rae. Photographs of the holotype were made using a Nikon camera connected to a Leica MZ 12.5 stereoscope; those of the newly described male with a Lumix camera connected to a Wild MD stereoscope. The drawings were made with a camera lucida mounted on a Leica MZ 12.5 stereoscope.

The following abbreviations are used in the text and figures: AME – anterior median eyes, PLE – posterior lateral eyes, PME – posterior median eyes.

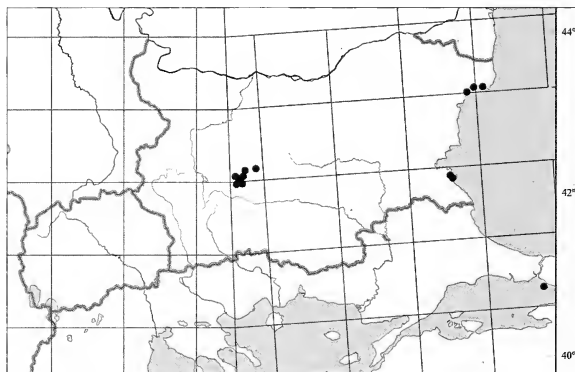


Fig. 1: Localities of *Zelotes strandi*

Taxonomy

Zelotes strandi (Nosek, 1905) (Figs 2–8, 10, 12, 14)
Prosthesima strandi Nosek, 1905: 126, f. 7

Material examined

TURKEY, Princess Islands, Prinkipo (Büyükada), Marmara Sea, #249 coll. A. Penther, ♀ holotype, 5.5.1902 (A. Penther leg.). BULGARIA: North Black Sea: Kavarna town, N43.458498°, E28.361197°, alt. 122 m, 1♀, 14.08.1996; Balchik town (dunes), N43.406734°, E28.125257°, alt. 111 m, 1♂ 2♀♀, 17.6.1995; Albena resort, N43.395426°, E28.088753°, alt. 234 m, 1♂, 23.06.1996; 1♂ 1♀, 11.10.1997 (V. Popov leg.). South Black Sea: Arkutino (dunes),

This contribution was presented at the 27th European Congress of Arachnology, Ljubljana, 2012 Sept. 2-7.

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N42.330895°, E27.734050°, 1 m alt., 1♂, 12.06.1996; Ropotamo river, N42.324380°, E27.730782°, 21 m alt., 1♀, 8.6.1996 (V. Popov leg.). Sushtinska Sredna Gora Mountains: Panagyuriste town, N42.508435°, E24.188566°, 533 m, 2♂♂ 4♀♀, 9.10.1998; Panagyuriste town, Kolonijte, N42.583370°, E24.190925°, alt. 1133 m, 1♂, 8.10.1997; Panagyuriste town, Milej, N42.541801°, E24.196221°, alt. 622 m, 1♀, 5.5.1997; Panagyuriste town, Nikulden, N42.516859°, E24.181875°, alt. 606 m, 1♀, 21.5.1998; 2♀♀, 08.09.1998; 5♂♂, 10.10.1998; 2♂♂ 1♀, 14.5.2000; Panagyuriste town, Sredoryak, N42.551685°, E24.188457°, alt. 696 m, 1♀, 6.5.1998; Panagyuriste town, Sveti Ivan, N42.515571°, E24.183635°, alt. 572 m, 3♀♀, 2.6.1998; Strelcha town, Barikadite, N42.574502°, E24.456701°, alt. 1284 m, 2♀♀, 2.6.1996 (S. Lazarov leg.).

Comparative material

Zelotes cingarus (O. P.-Cambridge, 1874). Bulgaria, Slavianka Mt, Kalimantsi vill., N 41.459735°, 23.489964°, alt. 462 m, 1♂ 3♀♀, 09.11.2002 (S. Lazarov leg.).

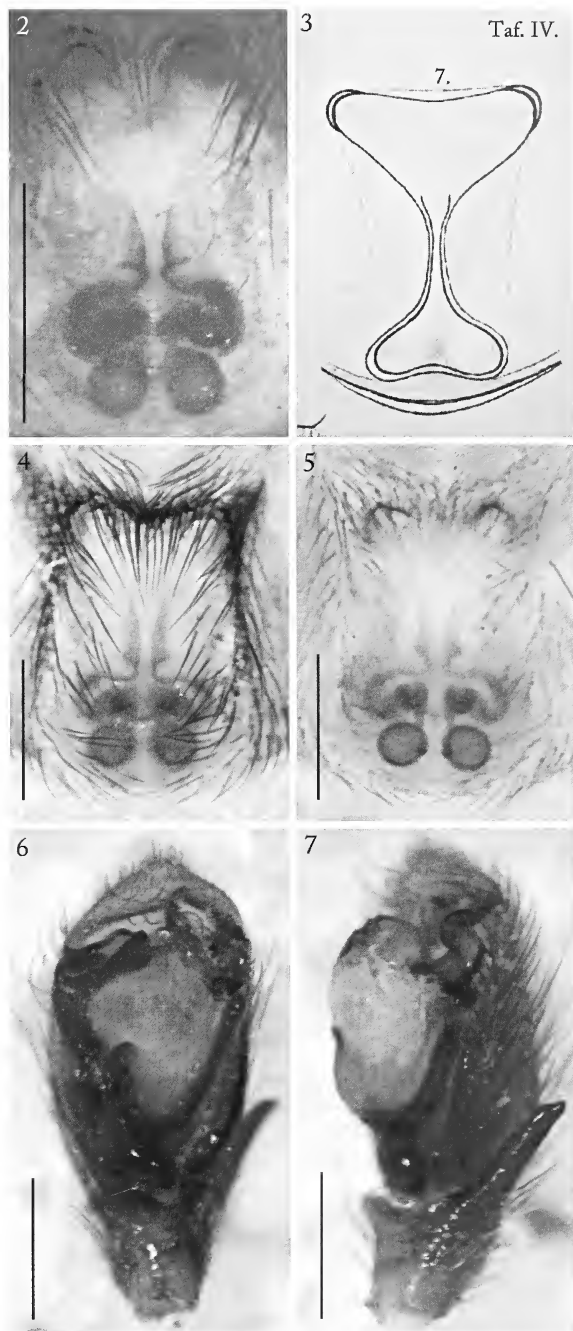
Depository

The holotype is housed in the Naturhistorisches Museum, Vienna. One pair (male and female) from Bulgaria, Panagyuriste town have been deposited at each of the following museums: Museum für Naturkunde, Humboldt-Universität, Berlin and Senckenberg Museum, Frankfurt am Main. The remaining 12 males and 18 females from Bulgaria are held in the collections of the National Museum of Natural History, Sofia.

Diagnosis and affinities

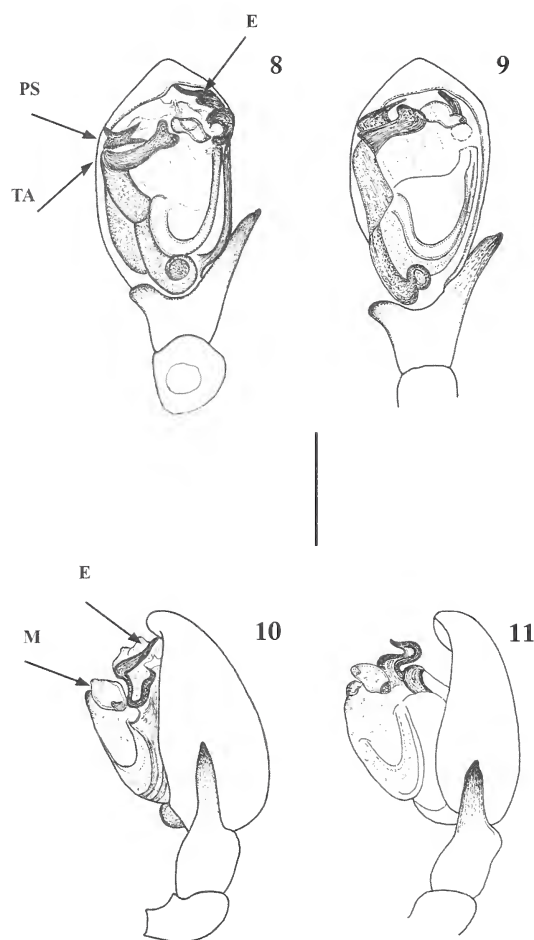
Somatic characters corresponding well to those of the genus. Male palp (Figs 8, 10) distinguished by the long tapering tibial apophysis, coiled embolar base, stout terminal apophysis with a bifid end and posterior sclerite with a characteristic shape; bifid distally. Female epigyne (Figs 12, 14) distinguished by the almost straight and parallel epyginal lateral margins, posteriorly forming U-shaped pockets. Anterior margins much wider than lateral ones. *Z. strandi* resembles *Zelotes cingarus* (O. P.-Cambridge, 1874) (Figs 9, 11, 13, 15), but differs in the following characters. In males of *Z. strandi* (Figs 8, 10) the tibial apophysis is longer; the terminal apophysis is longer and the bifid end is better expressed; the posterior sclerite of the terminal apophysis is bifid distally. In females of *Z. strandi* (Figs 12, 14), the lateral epyginal margins are less spaced, the spermathecae are smaller and the epigynal ducts are less coiled.

The original figure of the epigyne of *Z. strandi* by Nosek (1905) is very schematic and these features



Figs 2-7: *Zelotes strandi*: 2 – epigyne (type); 3 – epigyne (type), figure of Nosek (1905); 4 – epigyne (Bulgaria, Panagyuriste); 5 – vulva (Bulgaria, Panagyuriste); 6 – male palp, ventral view; 7 – male palp, retrolateral view

are not represented. The taxonomic value of the picture is thus low. It is effectively impossible to identify the species using the original illustration and this is



Figs 8–11: *Zelotes strandi*: 8 – male palp, ventral view; 10 – male palp, retrolateral view. *Zelotes cingarus* (Bulgaria, Slavianka Mt): 9 – male palp, ventral view; 11 – male palp, retrolateral view. E – embolus; M – median apophysis; PS – posterior sclerite; TA – terminal apophysis. Scale bar: 0.3 mm

probably the reason why *Z. strandi* was not recognised again in previous studies.

Description

Male: Total length 5.3; cephalothorax length 2.52; cephalothorax width 1.94 mm. Leg lengths:

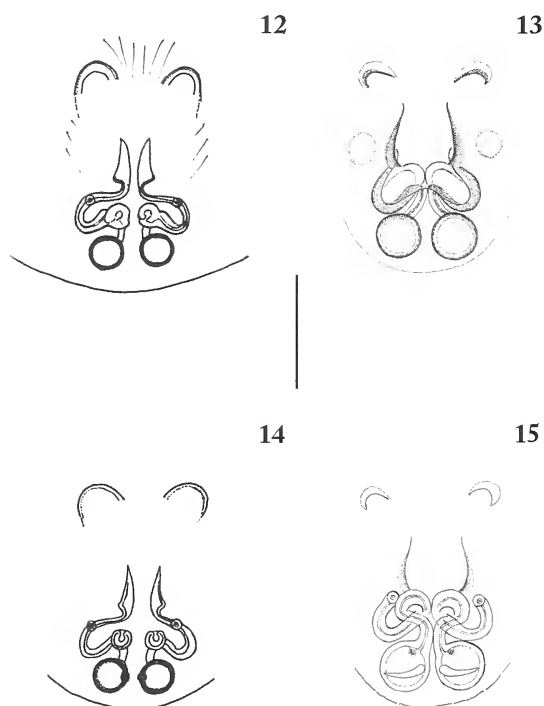
leg	I	II	III	IV
Femur	1.62	1.44	1.26	2.16
Patella	1.01	0.97	0.72	1.10
Tibia	1.26	1.01	0.90	1.44
Metatarsus	0.97	0.90	1.08	1.80
Tarsus	0.83	0.79	0.72	0.90
Total	5.69	5.11	4.68	7.31

Female: Total length 9.0; cephalothorax length 4.68; cephalothorax width 3.06 mm. Leg lengths:

leg	I	II	III	IV
Femur	2.88	2.27	2.16	2.80
Patella	1.62	1.26	1.08	1.62
Tibia	1.98	1.55	1.26	1.98
Metatarsus	1.62	1.40	1.26	2.52
Tarsus	1.26	1.08	1.08	1.26
Total	9.36	7.56	6.84	10.18

Posterior eye row with eyes of equal size and nearly equidistant. Chelicerae red-brown, armed with 3 teeth on outer margin of chelical furrow and 2 denticles on inner margin. Carapace, sternum and abdomen brown. Legs, spination: Fe: I–II d 2; II–IV d 6. Ti: I–II spineless; II–IV spinose. Me: I–II v 2; III–IV spinose.

Male palp (Figs 6–8, 10): Tibial apophysis long, slender and tapering. Embolic complex with an S-shaped base and a small, sclerotized embolus. Terminal apophysis stout with a bifid end. Posterior



Figs 12–15: *Zelotes strandi*: 12 – epigyne, 14 – vulva. *Zelotes cingarus* (Bulgaria, Slavianka Mt): 13 – epigyne, 15 – vulva. Scale bar: 0.3 mm

sclerite bifid distally. Median apophysis concave in the middle.

Epigyne (Figs 2–4, 12): Long and relatively narrow. Lateral epigynal margins anteriorly almost straight and parallel, posteriorly forming U-shaped pockets, anterior margins much wider than lateral ones.

Vulva (Figs 5, 14): Copulatory ducts long, leading to large, globular, slightly separated spermathecae.

Ecology

This species reaches altitudes of up to 1,200 m, but prefers lowlands. At higher altitudes it is found under stones, mainly at the edge of beach forests and meadows, in lowlands in dry grasslands, close to oak forests and dunes near the sea shore.

Phenology

Mature males were captured from April to September, females from May to October.

Distribution

Z. strandi seems to be widespread over the eastern part of the Balkan Peninsula. Until now, it has been captured in Bulgaria in several places, and in Turkey on the Prinkipo (Büyükdada) Island (Fig. 1).

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I am especially grateful to my colleagues S. Lazarov, I. Krusteva and V. Popov, for making their collected material available, to C. Hörweg for access to the collections of the

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Ground-living spiders in wooded habitats under human influence on an island in Finland

Seppo Koponen

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Abstract. Spiders were collected by pitfall traps in the south-western archipelago of Finland. Wooded study habitats on a small-sized (1.2 km²) island were: 1) natural open ash grove, 2) dense mixed grove (old overgrown wooded meadow), 3) wooded aspen pasture and 4) wooded meadow, both restored ten years earlier, 5) natural wooded meadow. Highest species and family numbers were found at the natural sites (1 and 5) and the lowest in the dense grove (site 2). Linyphiidae dominated, both at species and individual level, in the groves. Lycosidae were abundant on the wooded meadows and Gnaphosidae on the wooded pasture. The highest faunal similarities were between the groves (70 % species in common) and between the wooded meadows (64 %). The lowest similarity was found between the dense grove (17 %) and the ash grove (23 %) with the aspen pasture. Ten years after clearing, sites 3 and 4 had diverse spider faunas. The fauna at site 4 resembled that on the corresponding natural site (5), thus showing restoration success. Altogether 84 species of spiders were caught. The proportion of Gnaphosidae (16 species found) is high. Most species found in the study are common in south-western Finland and many occur across the whole country. *Pardosa lugubris* was most dominant at three sites, *P. pullata* and *Diplostyla concolor* both at one site. Two species, *Enoplognatha thoracica* and *Micaria fulgens*, are included in the Finnish Red Data Book.

Keywords: Araneae, archipelago, groves, habitat restoration, wooded meadows, wooded pastures

The island group Jungfruskär comprises three island and a few small islets. It is situated in the south-western archipelago of Finland, between the Turku archipelago and the Åland archipelago in an open sound called Skiftet (Fig. 1). Jungfruskär is located in the north-westernmost corner of the South-western Archipelago National Park. Due to its exceptionally diverse flora and fauna it is known as “the flagship of the Park” (Lindgren 2000).

The islands have been used as grazing sites for sheep, goats and cows for a few hundred years. Around 1850 some permanent inhabitants were settled on Storlandet (the study island), and after that felling of trees, cutting of upper parts of deciduous trees (pollarding) for fodder, and grazing itself became more active. This human activity produced special semi-natural habitats, like wooded meadows and wooded pastures. **Wooded meadows** are situated on the most fertile soils. They are rather open: usually 15–25 % coverage by copses of deciduous trees and shrubs, the rest being open meadow. Grass vegetation is rather short (due to hay harvesting and grazing) and the sites are characterized by many flowering plants, like the orchid

Dactylorhiza sambucina. **Wooded pastures** are found on fertile, but more stony, sites. In addition, also forests, dry meadows and shores were used as pastures.

During the 1960s human activity diminished, and many wooded meadows and other pastures began to overgrow. Clearing and opening of shrub lands started by volunteers in the 1980s and later also by the staff of the National Park (Lindgren 2000). This restoration activity has been very effective.

The aim of this paper is to document the composition and differences of ground-living spider communities in habitats which have been under different level of human activity on Storlandet, the main island of Jungfruskär.

Study area, material and methods

Jungfruskär is isolated from larger, forest growing land masses (islands). Larger islands to the south-east, south-west and west lay ca. 20 km from Jungfruskär, and those to the east, north and north-west ca. 10 km apart. The distances to the Finnish, Swedish and Estonian mainland are 60, 120 and 170 km respectively. The land area of the Jungfruskär island group is ca. 2 km² and that of the main island Storlandet 1.2 km². Its geographic location is 60° 8.35'N, 21° 4.69'E.

The land elevation here, caused by the Ice Age, is about half a meter per century. Therefore the highest hills in the island are about 3000–4000 years old, and

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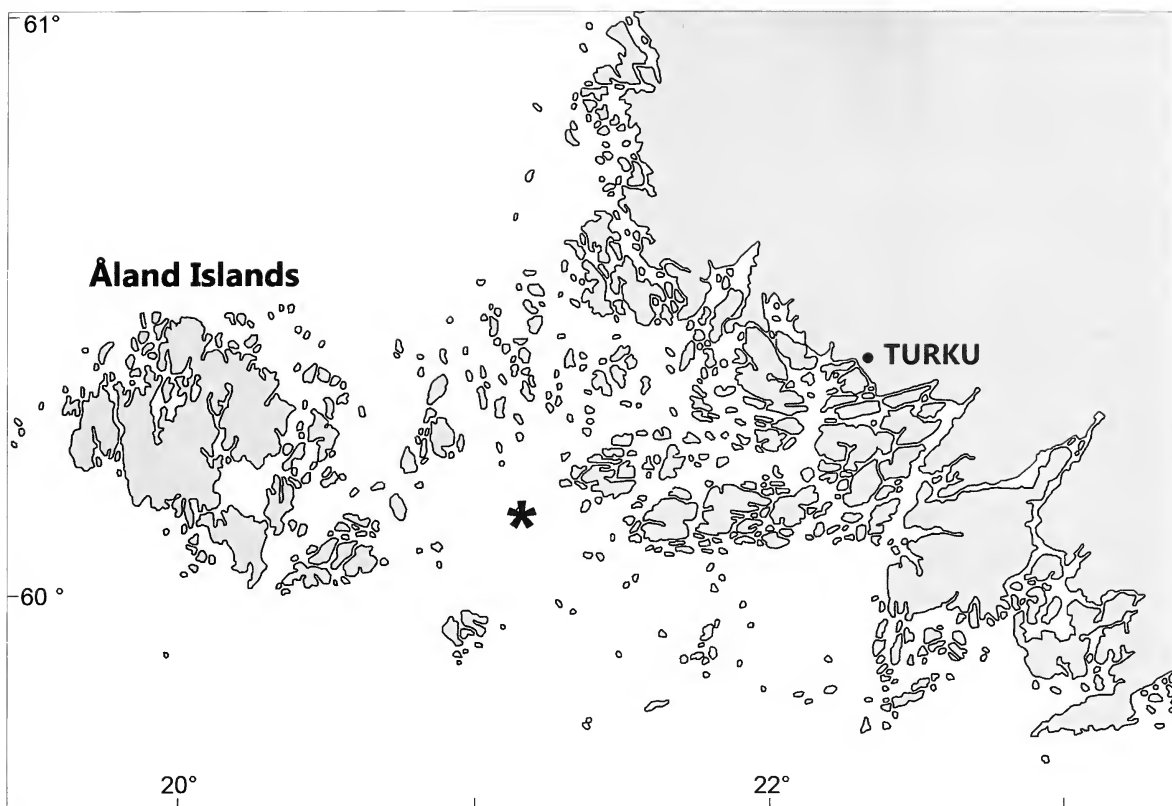


Fig. 1: The study island, Storlandet/Jungfruskär (*), in the SW archipelago of Finland.

the present study sites have been above sea level for about 400–1000 years.

Five wooded sites were studied on Storlandet. The elevation of the sites varied from 2 to 5 m a.s.l.

- 1) **Open ash grove** (natural). Trees: *Fraxinus excelsior* and *Alnus glutinosa*; abundant field layer plants: *Filipendula ulmaria*, *Urtica dioica*, *Anthriscus sylvestris* and *Allium scorodoprasum*.
- 2) **Mixed dense grove** (old overgrown wooded meadow), Fig. 2. Trees and shrubs: *Betula pubescens*, *Alnus glutinosa*, *Prunus padus*, *Viburnum opulus* and *Ribes alpinum*; field layer: *Milium effusum*, *Geum rivale*, *Filipendula ulmaria* and *Silene dioica*.
- 3) **Wooded aspen pasture** (junipers and coppice removed in 1997–98). Trees and shrubs: *Populus tremula* and *Ribes alpinum*; field layer: *Fragaria vesca*, *Rubus saxatilis*, *Primula veris* and different grasses. Also ground-laying rotten trunks of aspen. Before clearing it resembled site 2.
- 4) **Wooded meadow** (cleared in 1997–98). Trees: *Alnus glutinosa*, *Sorbus aucuparia* and *Prunus padus*; field layer: *Deschampsia cespitosa*, *Filipendula ul-*

maria, *Rubus idaeus*, *Geranium sylvaticum* and *Silene dioica*. Before clearing it resembled site 2.

- 5) **Wooded meadow** (natural) on calcareous moraine, Fig. 3. Trees: *Alnus glutinosa* and *Betula pubescens*; field layer: *Convallaria majalis*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Rhinanthus minor* and *Galium boreale*.

Ground-living spiders were collected using pitfall traps from 22 May to 11 September, 2007. Ten traps (diameter 6 cm, with propylene glycol and detergent, and covers) were placed at each site. Material consists of 1,299 adult, identifiable specimens, and is deposited in the Zoological Museum, University of Turku.

Results

Altogether, 84 species of spiders belonging to 12 families were caught by pitfall trapping (Tab. 1). The most species-rich families were Linyphiidae (41 species), Gnaphosidae (16), Lycosidae (9) and Thomisidae (7). The structure of the spider communities at the study sites is shown in Table 2. The highest

Tab. 1: Spider species collected in study habitats (sites 1-5) using pitfall traps, 2007.

site	1	2	3	4	5
Araneidae (1)					
<i>Zygiella atrica</i> (C. L. Koch, 1845)	.	1	.	.	.
Clubionidae (1)					
<i>Clubiona lutescens</i> Westring, 1851	2	.	.	.	.
Corinnidae (1)					
<i>Phrurolithus festivus</i> (C. L. Koch, 1835)	.	.	2	.	1
Gnaphosidae (16)					
<i>Callilepis nocturna</i> (Linnaeus, 1758)	.	.	2	.	.
<i>Drassodes pubescens</i> (Thorell, 1856)	.	.	4	1	.
<i>Drassyllus praeficus</i> (L. Koch, 1866)	.	.	7	.	.
<i>Drassyllus pusillus</i> (C. L. Koch, 1833)	.	.	2	.	8
<i>Gnaphosa bicolor</i> (Hahn, 1833)	.	.	8	.	.
<i>Haplodrassus signifer</i> (C. L. Koch, 1839)	.	.	6	2	.
<i>Haplodrassus silvestris</i> (Blackwall, 1833)	2	.	9	3	1
<i>Micaria aenea</i> Thorell, 1871	.	.	22	.	.
<i>Micaria fulgens</i> (Walckenaer, 1802)	.	.	1	.	.
<i>Micaria pulicaria</i> (Sundevall, 1831)	.	.	5	2	.
<i>Micaria subopaca</i> Westring, 1861	.	.	.	.	1
<i>Zelotes clivicola</i> (L. Koch, 1870)	.	.	1	.	.
<i>Zelotes latreillei</i> (Simon, 1878)	1	.	16	1	2
<i>Zelotes longipes</i> (L. Koch, 1866)	.	.	.	1	1
<i>Zelotes petrensis</i> (C. L. Koch, 1839)	.	.	11	.	.
<i>Zelotes subterraneus</i> (C. L. Koch, 1833)	4	.	.	.	.
Linyphiidae (41)					
<i>Agynphantes expunctus</i> (O. P.-Cambridge, 1875)	.	.	.	1	.
<i>Agyneta affinis</i> (Kulczyński, 1898)	.	.	3	.	2
<i>Agyneta conigera</i> (O. P.-Cambridge, 1863)	1	.	.	.	.
<i>Agyneta ramosa</i> Jackson, 1912	2	15	.	.	1
<i>Agyneta subtilis</i> (O. P.-Cambridge, 1863)	2	1	.	.	.
<i>Allomengea scopigera</i> (Grube, 1859)	1	.	.	.	.
<i>Anguliphantes angulipalpis</i> (Westring, 1851)	2	1	.	.	.
<i>Bathypantes gracilis</i> (Blackwall, 1841)	.	.	.	1	11
<i>Bathypantes nigrinus</i> (Westring, 1851)	.	.	.	1	.
<i>Bathypantes parvulus</i> (Westring, 1851)	.	3	.	6	.
<i>Centromerus arcanus</i> (O. P.-Cambridge, 1873)	.	1	.	.	.
<i>Ceratinella brevis</i> (Wider, 1834)	2	1	3	2	1.
<i>Ceratinella scabrosa</i> (O. P.-Cambridge, 1871)	16	.	.	.	.
* <i>Dicymbium nigrum</i> (Blackwall, 1834)	33	4	.	6	5
<i>Diplocephalus picinus</i> (Blackwall, 1841)	16	5	.	.	1
<i>Diplostyla concolor</i> (Wider, 1834)	3	67	1	.	3
<i>Erigone atra</i> Blackwall, 1833	2	.	.	.	3
<i>Erigonella biemalis</i> (Blackwall, 1841)	.	.	.	3	.
<i>Gonatium rubens</i> (Blackwall, 1833)	1	.	.	.	.
<i>Gongylidiellum latebricola</i> (O. P.-Cambridge, 1871)	.	.	.	.	1
<i>Gongylidium rufipes</i> (Linnaeus, 1758)	4	.	.	.	.
<i>Macrargus carpenteri</i> (O. P.-Cambridge, 1894)	.	.	1	.	.
<i>Macrargus rufus</i> (Wider, 1834)	4	.	.	.	.
<i>Maro minutus</i> O. P.-Cambridge, 1906	.	1	.	.	.
<i>Maso sundevalli</i> (Westring, 1851)	.	.	.	.	1

site	1	2	3	4	5
<i>Micrargus herbigradus</i> (Blackwall, 1854)	.	2	.	.	.
<i>Microneta viaria</i> (Blackwall, 1841)	.	3	.	.	.
<i>Panamomops mengei</i> Simon, 1926	.	.	1	.	.
<i>Porrhomma pallidum</i> Jackson, 1913	1	2	.	.	.
<i>Tapinocyba pallens</i> (O. P.-Cambridge, 1872)	4	9	.	.	.
<i>Tapinocyboides pygmaea</i> (Menge, 1869)	.	.	.	.	2
<i>Tapinopa longidens</i> (Wider, 1834)	2	.	.	.	.
<i>Tenuiphantes mengei</i> (Kulczyński, 1887)	1	.	.	.	.
<i>Tenuiphantes tenebricola</i> (Wider, 1834)	17	27	.	.	.
<i>Tiso vagans</i> (Blackwall, 1834)	16	.	.	39	11
<i>Walckenaeria antica</i> (Wider, 1834)	.	.	2	.	.
<i>Walckenaeria atrotibialis</i> (O. P.-Cambridge, 1878)	6	21	.	3	3
<i>Walckenaeria cucullata</i> (C. L. Koch, 1836)	3	2	.	.	1
<i>Walckenaeria dysderoides</i> (Wider, 1834)	.	.	1	.	.
<i>Walckenaeria unicornis</i> O. P.-Cambridge, 1861	1	.	.	.	.
<i>Walckenaeria vigilax</i> O. P.-Cambridge, 1861	1	.	.	1	1
Lycosidae (9)					
<i>Alopecosa pulverulenta</i> (Clerck, 1757)	4	.	62	.	2
<i>Alopecosa taeniata</i> (C. L. Koch, 1835)	.	.	1	1	.
<i>Pardosa fulvipes</i> (Collett, 1876)	8	.	.	.	9
<i>Pardosa lugubris</i> (Walckenaer, 1802)	88	4	72	81	12
<i>Pardosa palustris</i> (Linnaeus, 1758)	.	.	1	.	7
<i>Pardosa prativaga</i> (L. Koch, 1870)	1	.	.	.	1
<i>Pardosa pullata</i> (Clerck, 1757)	.	.	.	1	40
<i>Trochosa spinipalpis</i> (F. O. P.-Cambridge, 1895)	.	.	.	6	7
<i>Trochosa terricola</i> Thorell, 1856	17	2	48	47	24
Salticidae (1)					
<i>Neon reticulatus</i> (Blackwall, 1853)	1	.	.	.	.
Segestriidae (1)					
<i>Segestria senoculata</i> (Linnaeus, 1758)	1	.	.	.	.
Tetragnathidae (2)					
<i>Pachygnatha degeeri</i> Sundevall, 1830	.	.	47	11	25
<i>Pachygnatha listeri</i> Sundevall, 1830	19	11	.	2	.
Theridiidae (3)					
<i>Enoplognatha thoracica</i> (Hahn, 1833)	.	.	.	1	1
<i>Euryopsis flavomaculata</i> (C. L. Koch, 1836)	.	.	8	.	.
<i>Robertus lividus</i> (Blackwall, 1836)	1	.	.	.	.
Thomisidae (7)					
<i>Ozyptila atomaria</i> (Panzer, 1801)	.	.	.	.	3
<i>Ozyptila praticola</i> (C. L. Koch, 1837)	32	8	.	1	3
<i>Ozyptila trux</i> (Blackwall, 1846)	.	3	.	.	2
<i>Xysticus bifasciatus</i> C. L. Koch, 1837	.	.	1	.	.
<i>Xysticus cristatus</i> (Clerck, 1757)	.	.	.	.	4
<i>Xysticus erraticus</i> (Blackwall, 1834)	.	.	.	.	1
<i>Xysticus obscurus</i> Collett, 1877	.	.	.	.	5
Zoridae (1)					
<i>Zora spinimana</i> (Sundevall, 1833)	.	.	3	.	1
Total specimens	322	194	351	224	208
Total species	38	23	30	25	38

* editor's comment: only *Dicymbium nigrum brevisetosum* Locket, 1962 is known from Scandinavia

species and family numbers were found in the most natural sites (1 and 5), and smallest numbers in the dense, shady mixed grove (2). Clear differences were found in the family composition between sites. Linyphiidae clearly dominated, both at species and individual level, in the two studied groves. Lycosidae were most abundant on the two wooded meadows and Gnaphosidae on the wooded pasture (Tab. 2).

The six most abundant spider species at each site are listed in Tab. 3. Among the ten most abundant species in the groves (sites 1 and 2), the following six were shared in common: *Pardosa lugubris*, *Dicymbium nigrum*, *Ozyptila praticola*, *Pachygnatha listeri*, *Tenuiphantes tenebricola* and *Diplocephalus picinus*. Three species, *Pardosa lugubris*, *Pachygnatha degeeri* and *Trochosa terricola*, were among the top-ten at all three more open sites (3–5: wooded pasture and wooded meadows). In addition, *Haplodrassus silvestris*, *Tiso vagans* and *Trochosa spinipalpis* were abundant at two sites, i.e. in wooded meadows (sites 4 and 5). Dealing with all five habitats, a *Pardosa* species was the most dominant at four sites (*P. lugubris* at three and *P. pullata* once), and *Diplostyla concolor* in the dense grove. Species with high numbers at many sites also

include *Pachygnatha degeeri* and *Trochosa terricola*. Interestingly, only one species (*Pardosa lugubris*) was common in the top-ten lists of the mixed grove and wooded ash pasture. These are rather closely situated sites, and a decade prior to trapping (i.e. before restoration work) the wooded pasture was rather similar to the mixed grove. Only three of the total 84 species, *Ceratinella brevis*, *Pardosa lugubris* and *Trochosa terricola*, were caught at all five study localities.

Faunal similarity between the study sites is shown in Tab. 4. The highest similarity is between the two groves (Sørensen index: 0.52) and two wooded meadows (0.51), the smallest similarity to others is seen in the wooded aspen pasture: with mixed grove (0.15) and with ash grove (0.21). Interestingly, the mixed grove has low species similarity with wooded aspen pasture and wooded cleared meadow. Before restoration, i.e. ten years prior to trapping, the nature of these three sites resembled each other.

Discussion

The proportion of Gnaphosidae among the study material is high, especially in terms of species numbers. Altogether, 16 gnaphosid species were found, i.e. 19 % of the total species. For comparison, only 7 % of the Finnish spider fauna belongs to Gnaphosidae (Koponen 2008a). Reasons for the large number of Gnaphosidae are open and warm habitats as well as the situation of Jungfruskär in the southernmost part of Finland. High numbers of Gnaphosidae species and specimens have also been found previously on dry and open island habitats in the south-western Finnish archipelago (e.g. Koponen 2000, 2008b).

Ten years after restoration work, i.e. the clearing of sites 3 and 4, their spider fauna was rich and clearly different (both at species and family level) from the fauna found in their original habitat type (site 2). Very probably the openness (more light and warmth in summertime) is the key factor for a new faunal composition of the restored sites 3 and 4. The fauna of the cleared wooded meadow (site 4) clearly resembled that of the more natural wooded meadow (site 5). At least here, the restoration work has thus been successful. Although some studies on differences in spider communities during woodland restoration have been done (e.g. Ryndock et al. 2012), there seems to be no comparable data known from adjacent countries.

One of the species discovered, *Enoplognatha thoracica*, has been listed as a vulnerable species (VU)



Fig. 2: Mixed dense grove (site 2). – Photo: V. Rinne 2007



Fig. 3: Wooded meadow (site 5).
– Photo: V. Rinne 2007

in the recent Finnish Red Data Book (Pajunen et al. 2010). Jungfruskär (where the species was found on both wooded meadows) represents its third locality in Finland. In addition, *Micaria fulgens*, found in wooded aspen pasture, is listed as NT (nearly threatened) in the Red Data Book.

In general, the spider fauna found on Jungfruskär is typical for the south-western archipelago of Finland (cf. Koponen 2008b). Species with a general southerly distribution dominated. Thus the record

of *Xysticus obscurus*, known in Finland as a northern or boreal species, is interesting. Koponen (2008b) studied ground-living spiders in groves on two islands ca. 35 km east of Jungfruskär. Among the most abundant species in groves both on Jungfruskär, and on these eastern islands, were e.g. *Diplostyla concolor*, *Pardosa lugubris* and *Tenuiphantes tenebricola*. Some species, like the linyphiids *Dicymbium nigrum* and *Tiso vagans*, were found in high numbers on Storlandet in Jungfruskär compared to earlier studies done

Tab. 2: The structure of spider communities. Sites 1) natural open ash grove, 2) mixed dense grove, 3) wooded aspen pasture, 4) wooded meadow, 5) natural wooded meadow.

Site	1	2	3	4	5
Species	38	23	30	25	38
Families	9	5	8	6	8
Specimens	322	194	351	224	208
Species (%) of total					
Linyphiidae	63.2	73.9	23.3	40.0	39.5
Lycosidae	13.2	8.7	16.7	20.0	21.0
Gnaphosidae	7.9	0	43.3	24.0	13.2
Thomisidae	2.6	8.7	3.3	5.0	15.8
Individuals (%) of total					
Linyphiidae	43.8	85.1	3.4	28.1	22.6
Lycosidae	36.6	3.1	52.4	60.7	49.0
Gnaphosidae	2.2	0	26.8	4.5	6.3
Thomisidae	9.9	5.7	0.3	0.5	8.7

Tab. 3: Six most abundant spider species in the 5 sites.

Study site	%
1) Open ash grove	
<i>Pardosa lugubris</i>	27.3
<i>Dicymbium nigrum</i>	10.2
<i>Ozyptila praticola</i>	9.9
<i>Pachygnatha listeri</i>	5.9
<i>Tenuiphantes tenebricola</i>	5.3
<i>Trochosa terricola</i>	5.3
2) Mixed dense grove	
<i>Diplostyla concolor</i>	34.5
<i>Tenuiphantes tenebricola</i>	13.9
<i>Walckenaeria atrotibialis</i>	10.8
<i>Agyneta ramosa</i>	7.7
<i>Pachygnatha listeri</i>	5.7
<i>Tapinocyba pallens</i>	4.6
3) Wooded aspen pasture	
<i>Pardosa lugubris</i>	20.5
<i>Alopecosa pulverulenta</i>	17.7
<i>Trochosa terricola</i>	13.7
<i>Pachygnatha degeeri</i>	13.4
<i>Micaria aenea</i>	6.3
<i>Zelotes latreillei</i>	4.6
4) Wooded meadow	
<i>Pardosa lugubris</i>	36.2
<i>Trochosa terricola</i>	21.9
<i>Tiso vagans</i>	17.4
<i>Pachygnatha degeeri</i>	4.9
<i>Bathypantes parvulus</i>	2.7
<i>Dicymbium nigrum</i>	2.7
5) natural woded meadow	
<i>Pardosa pullata</i>	19.2
<i>Pachygnatha degeeri</i>	12.0
<i>Trochosa terricola</i>	1.5
<i>Pardosa lugubris</i>	5.8
<i>Bathypantes gracilis</i>	5.3
<i>Tiso vagans</i>	5.3

in the archipelago (Lehtinen et al. 1979, Clayhills et al. 2000, Koponen 2000, 2008b). The present material consists of 84 species, but the total number of spiders recorded from the small (1.2 km²) island of Storlandet in the rather isolated Jungfruskär island group is as high as 167 (Clayhills et al. 2008). It is more than one fourth of the known Finnish spider fauna (Koponen 2008a).

Tab. 4: Similarity between study sites (Sørensen index).

Sites	1	2	3	4	5
1	-	0.52	0.21	0.38	0.45
2		-	0.15	0.33	0.33
3			-	0.36	0.35
4				-	0.51
5					-

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Male palp organ morphology of three species of ground spiders (Araneae, Gnaphosidae)

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Abstract. A detailed morphological account of the male copulatory organs of three species of ground spiders, *Sergiolus capulatus*, *Herpyllus propinquus* and *Callilepis pluto* (Araneae, Gnaphosidae), is presented. The large sclerites (subtegulum, tegulum and embolus) appear to be homologous in all spiders. *Sergiolus* and *Zelanda* have a plesiomorphic palp organization. The increased complexity in the male bulb organization creates a locking mechanism that fixes the male palp position during intercourse in *Callilepis*, as well as in *Encoptarthria*, *Trachyzelotes* and *Zelotes*. The palp of *Herpyllus*, together with *Anzacia*, *Drassodes* and *Intruda*, demonstrates progressive modification of the male bulb.

Keywords: *Callilepis pluto*, ground-plan, *Herpyllus propinquus*, *Sergiolus capulatus*, tripartite male bulb

It is widely accepted that the male palp specifically fits into the female epigynum of the same species. The importance of male and female genitalia in species identification has long been recognized, since it was first used for this purpose (Westring 1861, Menge 1866, Wagner 1886, 1888, Engelhardt 1910, Comstock 1910, 1912).

Studies of male palp morphology show that the plesiomorphic state for this organ is characterized by a tripartite organization (Haupt 1983, Kraus 1978, 1984, Szombathy 1915). This type of palp consists of three basic sclerites – a subtegulum, tegulum and embolus – connected by three inflatable membranes: the basal, medial, and embolar hematochoae. This type of male palp organization was termed “hydraulic”, in contrast to the other type of the male palp he termed “glandular” (Kraus 1978, 1984). The latter is characterized by the progressive fusion of all three sclerites into one capsule, accompanied by complete reduction of the membranes and two bulb muscles. This progressive reduction of sclerites, membranes and muscles evolved several times (Kraus 1978, 1984, Huber 1994).

Gnaphosid spiders can be divided into three major groups according to their male palp organization

(Zakharov & Ovtcharenko 2011). The closest condition to the ancestral type of male palp was observed in *Zelanda erebus* (L. Koch, 1873); a peculiar species from New Zealand. *Drassodes lapidosus* (Walckenaer, 1802), *Intruda signata* (Hogg, 1900), and *Anzacia gemmea* (Dalmás, 1917) demonstrate significant “simplification” in the male palp construction. The embolic division of these spiders tends to fuse with the tegulum and, thus, transforms the palp into an essentially bipartite structure. By contrast, spiders of the genus *Encoptarthria* Main, 1954 demonstrate an increase in the complexity of male palp organization (Ovtcharenko & Zakharov 2007). Their palp contains an additional sclerite positioned between the tegulum and embolus, which probably functions as a flexible bridge and facilitates movement between the tegulum and embolus. This present study continues the morphological study of the expanded male palps of the ground spiders (cf. Zakharov & Ovtcharenko 2011).

Materials and methods

Genital bulbs of the following species – which represent two groups of gnaphosid spiders (the *Laronius* and *Herpyllus* groups) (Murphy 2007) – were studied: *Callilepis pluto* Banks, 1896, *Herpyllus propinquus* (Keyserling, 1887) and *Sergiolus capulatus* (Walckenaer, 1837). All three species were collected as follows: USA, Black Rock Forest, Cornwall, NY, 41°24'29"N 74°01'18"W, June 1999, leg. A. Tanasevitch and V. Ovtcharenko, coll V. Ovtcharenko.

The male palps of ground spiders for this study were prepared using a standard procedure (Comstock 1910, Sierwald 1990). The left palps were detached

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and submerged overnight in a weak watery solution of potassium hydroxide (KOH). It makes the bulb expand to various degrees. The bulb was then transferred into distilled water, where it continued to inflate. All prepared palps were preserved in 75 % alcohol. Drawings were made with the aid of a dissecting microscope (Nikon SMZ-U). Drawings were scanned and corrected with the computer program, Adobe Photoshop Lightroom 4.

Recent study on recognising homology status demonstrates that homology based on topology is the best criterion for male palp structures. A special similarity is close to that of topology and each criterion is better and contains fewer violations than homology based strictly on function (Agnarsson & Coddington 2008). This study supports the traditional view, and topology still remains the most reliable criterion of homology. For this reason, in order to reach a decision on the homologous status of a particular structure of the bulb, the following classical and widely applied criteria were used: 1) position of the structure; 2) morphological similarity with other known structures; 3) correspondence of the structure with other characteristics (Remane 1956, Patterson 1982, Coddington 1990, Sierwald 1990).

As noted above, it is generally accepted that the tripartite genital bulb in male spiders is a plesiomorphic characteristic (Platnick & Gertsch 1976, Kraus 1978, Haupt 1983, Sierwald 1990). This present study supports the conclusion that the large sclerites (subtegulum and tegulum) are homologous across all spiders (see also Kraus 1978, Coddington 1990, Sierwald 1990). These sclerites are organized around a tube. This tube has an enlarged, closed end (fundus), a long coiled tube (sperm duct), and a narrow tube with an opening at the end (ejaculatory duct) (Comstock 1910, 1912). This tube serves as a temporary sperm reservoir. Before mating, males fill their palps with sperm, which is stored here until mating occurs.

The terms proximal and distal here refer to the position of a structure in relation to the trajectory of the sperm duct. The structures that occupy a position close to the fundus are considered proximally located. On the other hand, the structures that are close to the ejaculatory duct are referred to here as distal.

The terms median apophysis and conductor are used to name tegular apophyses that are supposed to be homologous within all gnathosomids. An inflatable membranous projection on the upper surface of the

first half of the tegulum – which is merely an outgrowth of the membranous walls of the tegulum and is closely related to the tip of the embolus – is labeled the conductor. The median apophysis is a heavy sclerotized structure that occupies a position more distal on the tegulum than the conductor. It connects to the tegulum via an inflatable membrane, and does not directly associate with the embolus. The embolic division of the bulb is identified by the constriction of the sperm duct and its transformation into the narrow ejaculatory duct. According to this definition of the embolic division, the distal sclerotized tube is assigned to the embolic bulb division (Sierwald 1990).

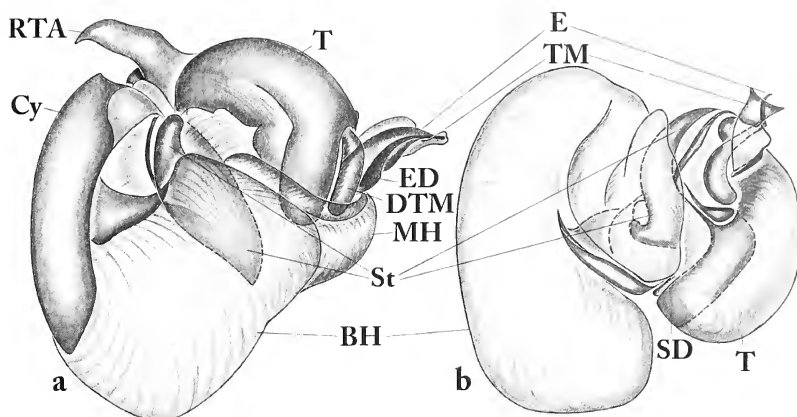
Results

The retrolateral tibial apophysis in *Sergiolus capulatus* (Walckenaer, 1837) is a simple, massive, hooked structure (Fig. 1). The basal and median hematodochae are well developed. The subtegulum and tegulum are open spirals with a single loop. The median apophysis and conductor are absent. The embolus is short, curved clock-wise, and grooved. The area of the embolus, close to its tip, has a membrane (Fig. 1, TM) which is associated with the embolus. The function of this membrane is unknown; it probably plays a supporting role during copulation. This membrane does not connect to the tegulum. Instead it is a membranous outgrowth of the base of the embolus. Thus, taking into account the topological criterion of homology (Agnarsson & Coddington 2008), it cannot be regarded as a conductor, and we refer to it as a “terminal membrane”. Proximally the embolus is attached to the distal tubular membrane, which connects it to the distal part of the tegulum.

In general, the bulb of the *Sergiolus* is very simple, tripartite, has three well-separated major sclerites (subtegulum, tegulum, and embolus), and lacks the median apophysis and conductor.

The retrolateral tibial apophysis of *Herpyllus propinquus* (Keyserling, 1887) is short, broad, slightly curved, and sharp at its tip (Fig. 2). The basal and medial hematodochae are well developed. The subtegulum and tegulum are heavily sclerotized rings. The median apophysis is a simple hook. The conductor is a comparatively simple, inflatable membrane. At its tip this membrane is divided into two lobes. The embolus is comparatively short. The proximal part of the embolus is broad and fuses with the tegulum. Its distal part is short, slender, hook-like, and rests in the groove between the top lobes of the conductor.

Fig. 1a-b: *Sergiolus capulatus*, left palp; a. Ventral view; b. Lateral view. BH – basal hematodocha; Cy – cymbium; DTM – distal tubular membrane; E – embolus; ED – ejaculatory duct; MH – median hematodocha; RTA – retrolateral tibial apophysis; SD – sperm duct; St – subtegulum; T – tegulum; TM – terminal membrane.



In conclusion, the bulb of *Herpyllus* is among the most modified male reproductive organs seen in the ground spiders. The fusion of the embolus with the tegulum transforms the male bulb of these spiders into a bipartite structure.

The male of *Callilepis pluto* Banks, 1896 does not have a retrolateral tibial apophysis (Fig. 3). The cymbium of these spiders is very characteristic. It is flattened; its length is two times longer than its width and somewhat spoon-shaped. The bulb is well-developed. A basal hematodocha connects the subtegulum to the petiolus and the alveolus of the cymbium. The median hematodocha connects the tegulum and subtegulum. There is a distal tubular membrane between the tegulum and embolus that binds them

through the distal tegular projection on one side and the broad base of the embolus on the other side.

The median apophysis is attached to the tegulum via a flexible membrane, approximately two-thirds of the way along the ventral part of the tegular ring. The insertion of the median apophysis on the tegulum is closer to the embolic division than the insertion of the conductor. The shape of the median apophysis is very unusual. It is divided into two large, massive, and heavily sclerotized hooks. The conductor is a small, weakly-developed outgrowth of the membrane that covers the tegulum.

The embolic part of the bulb is connected to the tegulum by the distal tubular membrane. This flexible membrane permits the embolus to rotate around

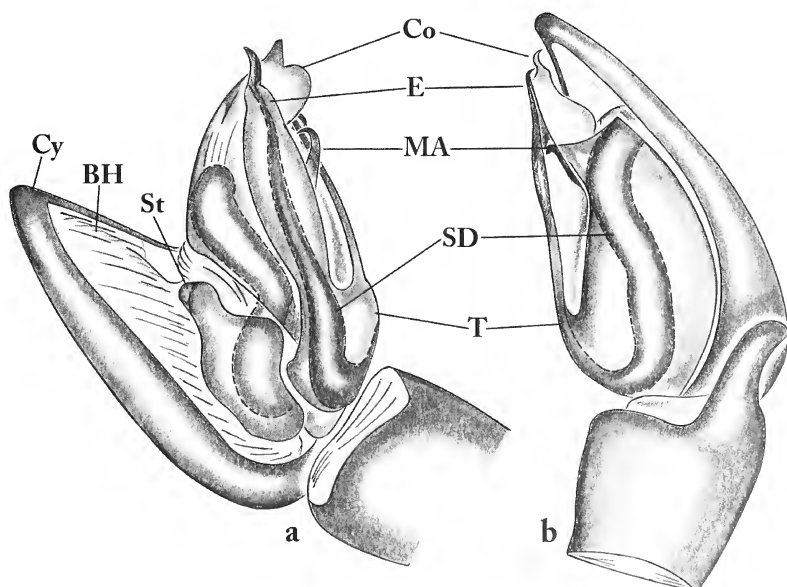


Fig. 2a-b: *Herpyllus propinquus*, left palp; a. Prolateral view; b. Retrolateral view. BH – basal hematodocha; Co – conductor; Cy – cymbium; E – embolus; MA – median apophysis; SD – sperm duct; St – subtegulum; T – tegulum.

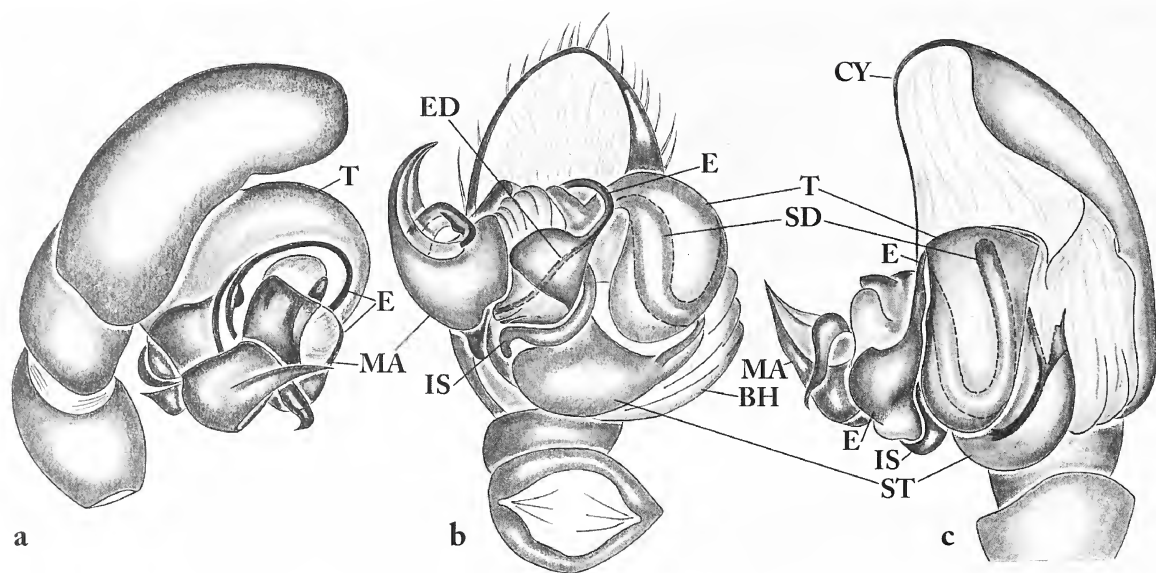


Fig. 3a-c: *Callilepis pluto*; left palp; a. Antero-retrolateral view; b. Ventral view; c. Prolateral view. BH – basal hematochocha; Cy – cymbium; E – embolus; ED – ejaculatory duct; IS – intercalary sclerite; MA – median apophysis; SD – sperm duct; St – subtegulum; T – tegulum.

the distal tegular projection as if it were an axis. The embolus is very long, slender, slightly flattened and semi-circularly curved. It has a broad basal part and bulged outgrowths on its distal part (embolar distal projection). The most peculiar structure found in the bulb of this species is a long, narrow sclerite between the tegulum and the embolus (Fig. 3, IS). Its position, special relations with other sclerites of the bulb and function are similar to the intercalary sclerite found in *Zelotes* (Platnick & Shadab 1983). It allows us to term this structure an “intercalary sclerite” here too. Probably, this additional sclerite increases the mobility of the embolus during copulation, as was described for *Zelotes* (Senglet 2004, 2011, 2012).

Discussion

Analysis of the present material allows us to further develop an understanding of the organization of the male palp in gnaphosid spiders. This study supports the previous observation that there are three basic ground-plans in gnaphosid male bulb morphology (Zakharov & Ovtcharenko 2011). The tripartite genital bulb in male spiders is a plesiomorphic characteristic (Platnick & Gertsch 1976, Kraus 1978, 1984, Haupt 1983, Coddington 1990, Sierwald 1990) and includes three basic sclerites: a subtegulum, tegulum and embolus that are bound together by inflatable membranes. These large sclerites (subtegulum,

tegulum and embolus) of all Entelegynae are homologous. The basic hematochocha – the membrane that attaches the subtegulum to the alveolus of the cymbium and the median hematochocha that binds the subtegulum and tegulum – are also homologous across all Entelegynae. The use of the term “terminal hematochocha” (Comstock 1910, 1912) should be avoided because its description and position in the bulb has not been clearly identified. Instead, the term “distal tubular membrane” is used here for the membrane that connects the distal part of the tegulum to the proximal end of the distal sclerotized tube or embolus. The term “terminal membrane” is proposed for the membranous outgrowth of the embolus.

Among ground spiders, the bulbs of *Sergiolus* and *Zelanda* are closest in morphology to that of the ancestral male palp. All major sclerites and membranes are present in the male bulbs of these spiders. Additionally, some derived palp forms have increased bulb complexity. The ground spiders of the genus *Callilepis*, as well as *Encoptarthria*, *Zelotes* and *Trachyzelotes* (Miller 1967, Platnick & Shadab 1983, Senglet 2004, 2011, 2012, Zakharov & Ovtcharenko 2011), have additional sclerites in the embolic division. They have a distal sclerotized tube (in *Encoptarthria*) or an intercalary sclerite (in *Callilepis* and *Zelotes*) between the tegulum and embolus that are flexibly connected to each other. This additional sclerite

rite increases the mobility of the embolic part of the bulb. Furthermore, on the embolic part of the bulb, these spiders have subterminal and terminal apophyses. The presence of a number of additional sclerites in the embolar part suggests that increased complexity in the male bulb organization creates a locking mechanism during intercourse in these spiders (Sierwald & Coddington 1988, Huber 1994).

Herpyllus, together with the genera *Anzacia*, *Drassodes* and *Intruda* (Zakharov & Ovtcharenko 2011), represents progressive reduction of the number of sclerites in the male bulb. The proximal part of the embolus and the distal end of the tegulum in these spiders are fused. Thus, the embolus in these spiders is firmly attached to the tegulum and the distal tubular membrane completely disappears. The other major sclerites of the bulb in spiders of these genera are also significantly reduced.

Male bulb evolution in ground spiders was not linear, and analogous structures may appear independently in different groups. Such parallel evolution of the male palp – characterized by a secondary simplification through fusion of the apical and median bulbus sclerites and simultaneous reduction of the extensible membrane – has occurred independently in many groups of spiders. It was observed in orthognath (e.g. Theraphosidae), haplogyne (Sicariidae, Scytodidae, Pholcidae), and entelegyne spiders (*Castianeira*, Corinnidae) (Kraus 1984, Huber 1994). These observations suggest that there is a tendency in male spider palp evolution for the “pyriform male palp organ” to develop into the “glandular bulb” (Kraus 1984). Gnaphosid spiders also follow this major evolutionary trend, by which the embolus of their bulb fuses with the tegulum and thus changes the tripartite male palp into the bipartite. This process took place independently many times in different groups of the gnaphosid spiders. We observe this in the present study in *Herpyllus*, and it was previously seen in *Drassodes* and *Intruda* (Zakharov & Ovtcharenko 2011). Another phenomenon of the parallel transformation of the male bulb happens with those ground spiders whose male palpal organ undergoes an increase of external construction complexity. Thus, we have found the intercalary sclerite in the bulb of *Callilepis pluto*. The topology, special similarity, and function of this sclerite are the same as the intercalary sclerite in *Zelotes*. However, these two genera belong to different subfamilies of gnaphosid spiders and imply that they may have developed independently.

Acknowledgments

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Nachweise für Mecklenburg-Vorpommern neuer und seltener Spinnenarten (Arachnida, Araneae)

Dieter Martin

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Abstract. Records of new and rare spider species from Mecklenburg-Western Pomerania (Arachnida, Araneae). The first records for Mecklenburg-Western Pomerania, Germany, of the species *Mermessus trilobatus*, *Parasteatoda tabulata* and *Araniella inconspicua* are provided, together with noteworthy occurrences of the rare species *Ero tuberculata*, *Jacksonella falconeri*, *Philodromus histrio* and *Oxyopes ramosus*.

Keywords: faunistics, Germany

Mit der Neufassung der Roten Liste der Spinnen Mecklenburg-Vorpommerns (Martin 2012) wurde auch die Gesamtartenliste des nordöstlichen Bundeslandes aktualisiert. Sie umfasst 572 Arten von Webspinnen (Araneae). Mittlerweile konnten vor allem durch die Sammeltätigkeit von K. Rudnick (Bergen auf Rügen), aber auch durch eigene Aufsammlungen weitere drei Arten nachgewiesen werden, die über die oben genannte Checkliste hinaus neu für Mecklenburg-Vorpommern sind. Die Gesamtzahl der Spinnenarten Mecklenburg-Vorpommerns erhöht sich somit auf 575.

Besonders bemerkenswert sind die Erstnachweise von *Mermessus trilobatus* und *Parasteatoda tabulata* in Mecklenburg-Vorpommern. Sie markieren die jeweils nordöstlichsten Fundpunkte der offenbar in Arealausweitung befindlichen Adventivarten in Deutschland.

Das Belegmaterial befindet sich in der Sammlung des Verfassers. Die Nomenklatur richtet sich nach Platnick (2012).

Mermessus trilobatus (Emerton, 1882)

Synonym *Eperigone trilobata*

1♂, Meesiger, Naturpark Mecklenburgische Schweiz und Kummerower See, (MTB 2143, 53°48'46" N, 12°54'06" E, 6 m ü. NN), Bodenfalle 14.–30.8.2012, Sandmagerrasen (leg. D. Martin).

Der erste europäische Nachweis der aus Nordamerika stammenden Art gelang 1981 in einem Buchenwald bei Karlsruhe (Dumpert & Platen 1985). Seither erfolgte eine stetige Arealerweiterung über

mehrere mittel- und südeuropäische Länder (Helsing 2009, Dolanský et al. 2009, Rozwałka 2010, Nentwig et al. 2012). In Deutschland ist die Art weit in den Norden vorgedrungen (Staudt 2012). Der vorliegende Fund belegt die Art erstmalig für das Bundesland Mecklenburg-Vorpommern und stellt gleichzeitig den bislang nördlichsten Fundpunkt in Deutschland dar (Abb. 1).

Die Art besiedelt ein breites Spektrum an Lebensräumen (Hänggi et al. 1995). Nach Kielhorn (2007) werden Offenlebensräume (Grünland, Brachen, nicht aber bewirtschaftete Äcker) präferiert, wobei keine Bindung an bestimmte Feuchtigkeitsverhältnisse erkennbar ist. Andererseits stammen mehrere Nachweise aus Waldlebensräumen (Buchenwälder, Aue- und Feuchtwälder) (Dumpert & Platen 1985, Kielhorn 2011). Auch bezüglich der Lichtverhältnisse verhält sich die Art also offenbar tolerant. Der vorliegende Fund in einem süd-exponierten Sandmagerrasen sowie teilweise die begleitende Araneofauna (*Alopecosa schmidtii*, *Alopecosa barbipes*, *Cheiracanthium virescens*) lassen eine Thermophilie der Art vermuten.

Parasteatoda tabulata (Levi, 1980)

Synonym *Achaeareanea tabulata*

1♂, Rügen, Bergen, Plattenbau-Wohngebiet (MTB 1546, 54°24' N, 13°25' E, 30 m ü. NN), 26.6.2012, auf Gehwegplatten, Handfang (leg. K. Rudnick).

Die eusynanthrop an Häusern im städtischen Bereich lebende Art (Komposch 1993) ist nach Platnick (2012) holarktisch verbreitet und wurde bislang in Nordamerika, Ostasien und Europa gefunden. Die ersten europäischen Nachweise erfolgten durch Moritz et al. (1988) aus Deutschland (Berlin-Marzahn und Brandenburg) sowie Knoflach (1991) aus Österreich (Innsbruck). Mittlerweile wurde die ihr

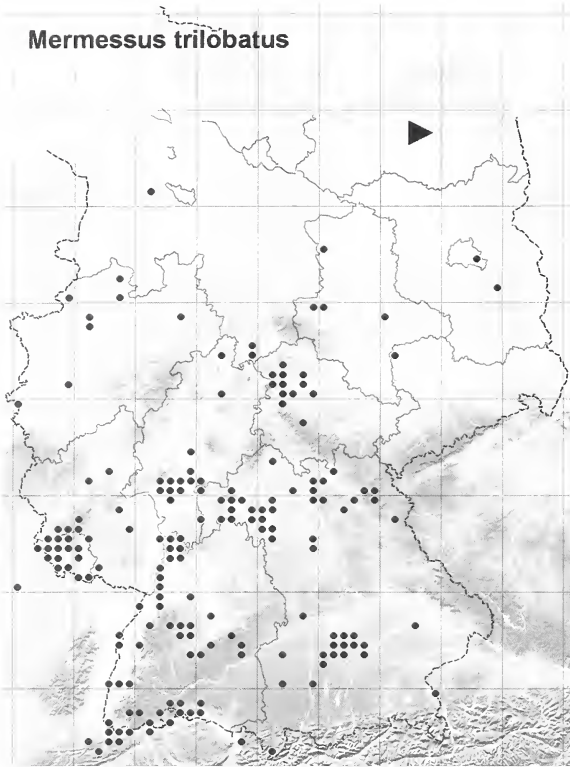


Abb. 1: Nachweise von *Mermessus trilobatus* (nach Staudt 2012).

Fig. 1: Records of *Mermessus trilobatus* (after Staudt 2012).

► vorliegender Neunachweis/new record

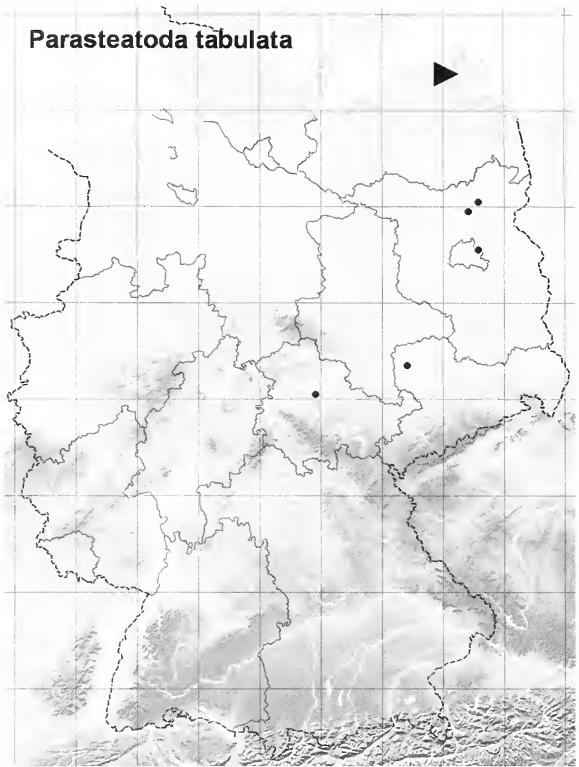


Abb. 2: Nachweise von *Parasteatoda tabulata* (nach Staudt 2012).

Fig. 2: Records of *Parasteatoda tabulata* (after Staudt 2012).

► vorliegender Neunachweis/new record

Areal expandierende Art in zahlreichen weiteren mittel- und osteuropäischen Ländern nachgewiesen (Nentwig et al. 2012, Šestaková & Gajdoš 2011).

Staudt (2012) verzeichnet neben den o. a. Fundorten in Berlin und Brandenburg zusätzlich zwei Funde aus Sachsen und Thüringen sowie einen weiteren Fundpunkt aus Brandenburg (MTB 3046).

Der vorliegende Fund der sehr seltenen Kugelspinnenart ist damit nicht nur der Erstnachweis für Mecklenburg-Vorpommern, sondern zugleich der bislang nördlichste Fundpunkt in Deutschland (Abb. 2).

Araniella inconspicua (Simon, 1874)

1♂, Groß Molzahn (MTB 2231, 53°52'23" N, 10°58'06" E, 1 m ü. NN), Seggenwiese, Kescherfang, 9.5.2012 (leg. K. Rudnick).

Araniella inconspicua ist eine der seltensten *Araniella*-Arten Europas (Sacher 1984). Sie fehlte bislang in Mecklenburg-Vorpommern, wurde aber in Grenznähe in Niedersachsen (Lemke 2010) sowie

in Schleswig-Holstein (M. Lemke, nach Staudt 2012) gefunden. Der vorliegende Nachweis aus Nordwest-Mecklenburg schließt sich letzterem unmittelbar an.

Ero tuberculata (De Geer, 1778)

1♂, Göhren-Lebbin, OT Untergöhren (MTB 2541, 53°29'27" N, 12°29'38" E, 70 m ü. NN), 31.7.2012, Aeronaut, an Hauswand ca. 3 m von einer Kiefer entfernt (leg. D. Martin).

Die selten gefundene Spinnenfresserart ist in Schleswig-Holstein, Niedersachsen und Brandenburg nachgewiesen (Staudt 2012), fehlte aber bislang in Mecklenburg-Vorpommern. Der vorliegende, in der aktuellen Checkliste (Martin 2012) bereits berücksichtigte Fund schließt diese Lücke.

Von Broen (1993) verweist auf eine Bevorzugung trocken-warmer Standorte. Dem entsprechen auch die Angaben bei Hänggi et al. (1995). Nach Lemke (2008) lebt die Art auf den unteren Zweigen von Nadelbäumen. Eine Nachsuche (Klopfen) an den Ästen

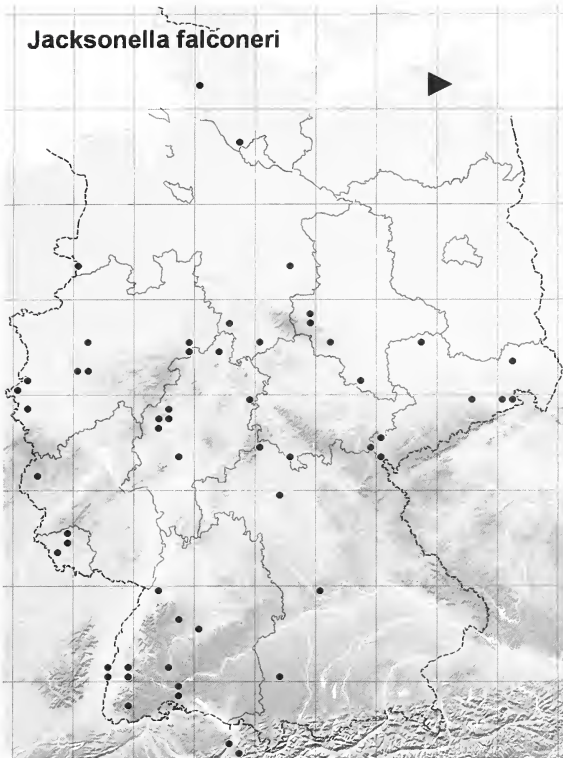


Abb. 3: Nachweise von *Jacksonella falconeri* (nach Staudt 2012).
Fig. 3: Records of *Jacksonella falconeri* (after Staudt 2012).
▶ vorliegender Neunachweis/new record

der in der Nähe des Fangortes stehenden Kiefer blieb allerdings erfolglos.

Jacksonella falconeri (Jackson, 1908)

1♀, Rügen, Halbinsel Drigge, Boddenufer (MTB 1745, 54°17'20" N, 13°10'25" E, 1 m ü. NN), Hochstaudenflur, Kescherfang, 25.5.2010 (leg. K. Rudnick).

Die Erstmeldung für die deutsche Fauna erfolgte durch Wunderlich (1972) sowie Moritz (1973). Nach letzterem befinden sich in der Sammlung des Naturkundemuseums in Berlin allerdings Belege bereits aus dem Jahr 1902, die F. Dahl in Schleswig-Holstein sammelte.

Obwohl bei Staudt (2012) mittlerweile zahlreiche Funde dokumentiert sind, fehlt die Art bislang im gesamten Nordosten Deutschlands. Der vorliegende Fund an der Südküste Rügens erweitert somit das Nachweisgebiet beträchtlich (Abb. 3). *Jacksonella falconeri* wurde in der aktuellen Checkliste Mecklenburg-Vorpommerns (Martin 2012) bereits berücksichtigt.

Die ökologischen Ansprüche der Art sind noch unklar. Während Wunderlich (1973) Xerothermhänge verzeichnet, nennt Moritz (1973) vor allem verschiedene Feuchtlebensräume. Der vorliegende Fund reiht sich hier ein. Nach Hänggi et al. (1995) dagegen beziehen sich die meisten Nennungen auf Waldlebensräume.

Philodromus histrio (Latreille, 1819)

1♂, Grabower Heide (MTB 2735, 53°15' N, 11°35' E, 35 m ü. NN), *Calluna*-Heide, auf trockenem Heidekraut, 9.5.2012, leg. K. Rudnick).

Der vorliegende Fund ist der zweite Nachweis der Art in Mecklenburg-Vorpommern. Erstmals wurde sie durch Buchholz & Schirmel (2011) in den Küstendünenheiden der Insel Hiddensee gefunden. In Schleswig-Holstein existiert bislang auch nur ein Nachweis im Lübecker Raum in unmittelbarer Nähe zur Landesgrenze von Mecklenburg-Vorpommern (M. Lemke, nach Staudt 2012). Südlich des aktuellen Fundortes schließt sich ein Vorkommen in Sandtrockenrasen in Niedersachsen an (Merkens 2000).

Oxyopes ramosus (Martini & Goeze, 1778)

2 subad., Grabower Heide (MTB 2735, 53°15' N, 11°35' E, 35 m ü. NN), *Calluna*-Heide, auf trockenem Heidekraut, 9.5.2012, leg. K. Rudnick).

Die zwei bislang existierenden Nachweise der Art in Mecklenburg-Vorpommern – gleichzeitig die nördlichsten in Deutschland – liegen bereits Jahrzehnte zurück (Rabeler 1931: Göldeitzer Hochmoor; Martin 1983: NSG „Ostufer der Müritz bei Waren – jetzt Müritz Nationalpark). Der vorliegende Fund bestätigt das aktuelle Vorkommen der Art in Mecklenburg-Vorpommern.

Danksagung

Für seine unermüdliche Sammeltätigkeit danke ich Herrn Kurt Rudnick, der mir neben zahlreichen anderen interessanten Spinnenfunden auch den Großteil der hier aufgeführten Arten zur Bearbeitung überließ. Theo Blick sowie den Gutachtern der Arachnologischen Gesellschaft danke ich für ihre wertvollen Hinweise.

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First record of a schizomid, *Stenochrus portoricensis* (Schizomida: Hubbardiidae), in Slovakia

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Abstract. The discovery of *Stenochrus portoricensis* Chamberlin, 1922 is the first record of the order Schizomida in Slovakia. Juvenile specimens and adult females were found in heated greenhouses in the Botanical Garden of the Comenius University in Bratislava, Slovakia. The main morphological characters of juveniles and adult females were studied and photographed.

Keywords: Central Europe, faunistics, greenhouse, introduced species, short-tailed whipscorpion

The order Schizomida is a small group of arachnids, currently represented by two recent families: Proto-schizomidae Rowland, 1975 with two genera and 12 species; and Hubbardiidae Cook, 1899 with 48 genera and 271 species worldwide (Harvey 2007, Armas 2010, Monjaraz-Ruedas 2012). Schizomids can be found in leaf litter, under rocks, in caves and other subterranean voids, in many tropical and subtropical regions of the world. Some species have been recorded from greenhouses and other artificial environments in Europe, demonstrating their ability to withstand long-distance transport by human commerce (Harvey 2003). Three species have previously been recorded from greenhouses in Europe. *Schizomus crassicaudatus* (O. P.-Cambridge, 1872) was introduced from Sri-Lanka into France. *Zomus bagnallii* (Jackson, 1908) was introduced from South-east Asia, the Seychelles or Mauritius into Great Britain (Harvey 2003, Blick 2006). *Stenochrus portoricensis* Chamberlin, 1922 has been introduced into Great Britain, Spain (Canary Islands) and the Czech Republic (Harvey 2003, Blick 2006, Korenko et al. 2009). All of the specimens from Europe were collected from heated greenhouses. Undetermined schizomids have been collected from two greenhouses in Germany (Cokendolpher et al. 2006).

Material and methods

The schizomids were found in two heated greenhouses (temperature about 26 °C) situated in the same part of the Botanical Garden of the Comen-

ius University in Bratislava (Fig. 1A), Slovakia (grid reference number of the Databank of Slovak Fauna 7868; 48°08'49.2"N; 17°04'20.97"E; 148 m a.s.l.; lgt. J. Christophoryová, P. Fend'a, K. Krajčovičová & A. Šestáková). Thirteen juvenile specimens were extracted from soil samples using Tullgren funnels (9 May 2012: 3 juveniles, 7 June 2012: 2 juveniles, 22 November 2012: 8 juveniles). Seven females were individually collected (22 November 2012) under the stones (Fig. 1B) and two were extracted from soil samples (22 November 2012).

Two juveniles and five females were dissected, studied as permanent slide mounts, and photographed using a Leica DM1000 stereoscopic microscope with an ICC50 Camera Module (LAS EZ application 1.8.0). Other specimens were preserved in 80 % or 96 % ethanol and were photographed using a digital camera CANON EOS 1100D connected to a Zeiss Stemi 2000-C stereomicroscope. The female genitalia were dissected in 96 % ethanol and macerated using NaOH solution, after which they were mounted on a permanent slide in Swan's fluid. Digital images were montaged using the "CombineZP" image stacking software. The specimens were identified by J. Christophoryová and M. Krumpál. The material is deposited in the collection of the first author in the Comenius University, Bratislava.

Results and discussion

Main morphological features

The adult female of *Stenochrus portoricensis* (Fig. 2A) is characterised by the following morphological features (Rowland & Reddell 1980, Reddell & Cokendolpher 1995, Tourinho & Kury 1999, Armas 2010): propeltidium with two apical setae on an anterior process arranged one behind the other and two pairs

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Fig. 1: Heated greenhouses in the Botanical Garden of the Comenius University in which *Stenochrus portoricensis* occurs. A. Interior view of greenhouse. B. Detail of the stones under which females were collected. – Photos: Jana Christophoryová

of dorsal setae (Fig. 3A); corneate eyes completely absent; metapeltidium entire; movable cheliceral finger without accessory teeth (Fig. 3B), guard tooth present at end of serrula; short mesal spur present on pedipalpal trochanter (Fig. 3C); body without clavate setae; abdominal tergite II with two posterior setae; flagellum short, with three segments (Fig. 3D); spermathecae (Fig. 3E) with two pairs of asymmetric lobes, the laterals clearly shorter than the medians, both lobes with a wrinkled wall covered with small bumps, the median lobes heavily sclerotized and visible without dissection through the genital sternite, gonopod short.

At first, only juvenile specimens were collected during our research in the Botanical Garden of the Comenius University. Their identification was difficult because the majority of recent schizomid descriptions are based on the characters of adults. The juveniles were smaller and markedly less sclerotized (Fig. 2B) and were characterized by features typical for the genus (Fig. 4). The identification of the species was equivocal prior to finding the females.

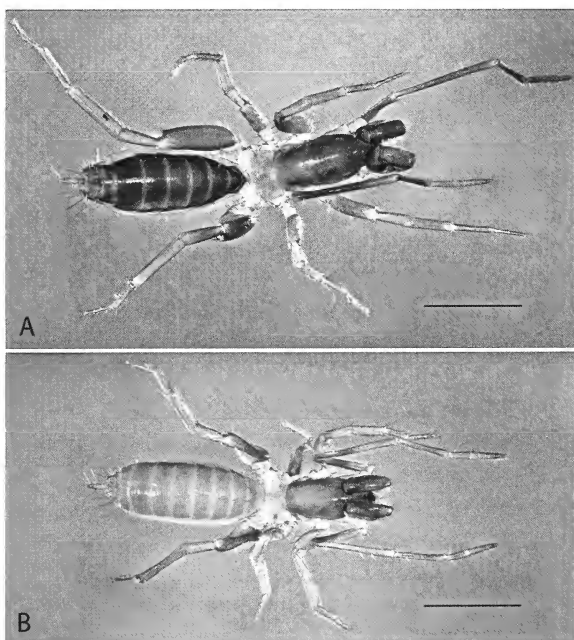
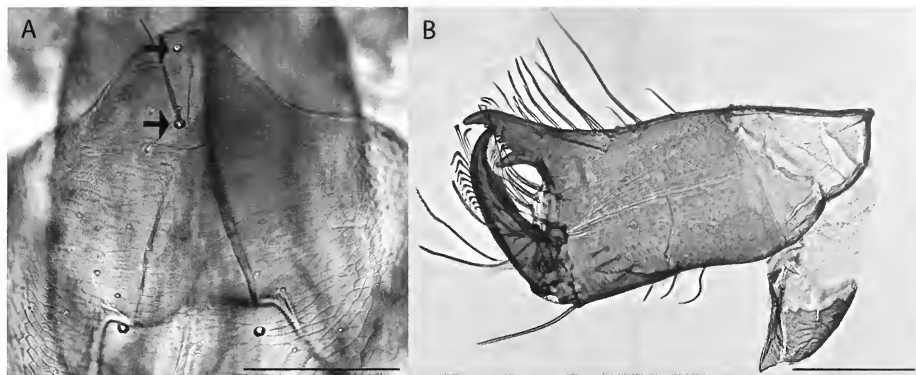


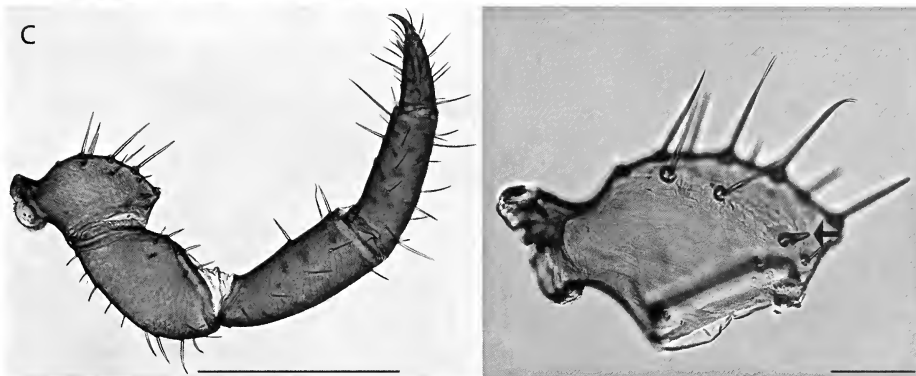
Fig. 2: *Stenochrus portoricensis* from Slovakia. A. Female. B. Juvenile. Scales: 1 mm. – Photos: Anna Šestáková

Fig. 3: Morphological characters of *Stenochrus portoricensis* female (microscope slides). – Photos: Jana Christophoryová

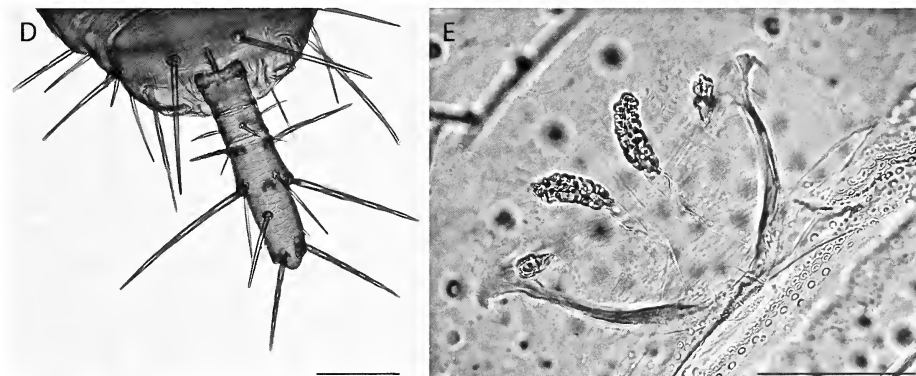
A. Detail of anterior part of propeltidium (dorsal view). Arrows point to apical propeltidial setae. B. Chelicera (lateral view). Scales: 0.2 mm (A, B)



C. Pedipalp with detail of trochanter (prolateral view). Arrow points to mesal spur on trochanter. Scales: 0.5 mm (C), 0.1 mm (C detail)



D. Flagellum (dorsal view). E. Spermathecae (dorsal view). Scales: 0.1 mm (D, E)



Natural history

Stenochrus portoricensis naturally occurs in Mexico and the Caribbean, but has been introduced to many other countries (e.g. the USA, Rio de Janeiro in Brazil, Colombia, Ecuador, the Canary Islands, Great Britain and the Czech Republic) (Reddell & Cokendolpher 1995, Tourinho & Kury 1999, Harvey 2003, Korenko et al. 2009, Kury et al. 2010). The majority of the males are known from southern Mexico, but some have been found on Caribbean Islands (Tourinho & Kury 1999). The species is fac-

ultatively parthenogenetic (Martín & Oromí 1984) and only females and juveniles have been found in heated greenhouses (Cloudsley-Thompson 1949, Korenko et al. 2009). Parthenogenesis in this species probably facilitates its importation. This species has been reported from caves, under rocks, in leaf litter and soil, in both synanthropic and disturbed habitats (Rowland & Reddell 1980, Martín & Oromí 1984, Reddell & Cokendolpher 1995, Tourinho & Kury 1999, Santos et al. 2008, Armas 2010). Some specimens have been collected in association with

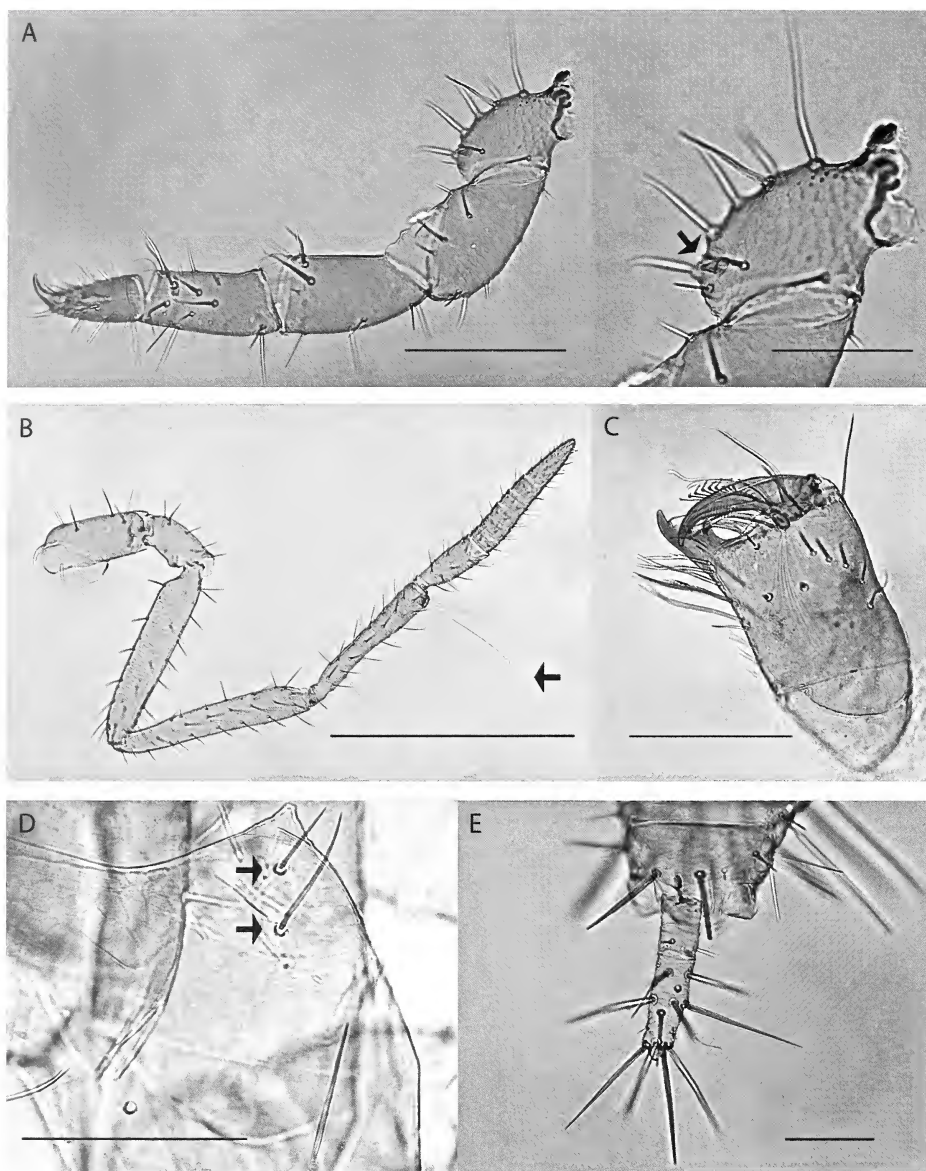


Fig. 4: Morphological characters of *Stenochrus portoricensis* juvenile (microscope slides). – Photos: Jana Christophoryová

A. Pedipalp with detail of trochanter (prolateral view). Arrow points to the mesal spur on trochanter. Scales: 0.2 mm (A), 0.1 mm (A detail)

B. Leg I (lateral view). Arrow points to one of the trichobothria on tibia. C. Chelicera (lateral view). Scales: 0.5 mm (B), 0.2 mm (C)

D. Detail of anterior part of propeltidium (dorsolateral view). Arrows point to apical propeltidial setae. E. Flagellum (dorsal view). Scales: 0.1 mm (D, E)

ants and termites (Martín & Oromí 1984, Reddell & Cokendolpher 1995, Santos et al. 2008). In Tenerife, only females are known from volcanic pit at low altitude (Martín & Oromí 1984, Oromí & Martín 1992). In the Czech Republic, the species was found under pieces of bark lying on wet soil in a greenhouse in the Botanical Garden of Masaryk University, Brno (Korenko et al. 2009).

The records provided in the current study are consistent with known natural history patterns. *Stenochrus portoricensis* occurs in Slovakia in heated

greenhouses, with a temperature of about 26 °C, in the soil and under stones. There have not been importations of plants from tropical areas or other botanical gardens for several years and some insecticides have been regularly applied one to two times per month (Vertimex, Confictor, Omite). According to these facts, the population of *S. portoricensis* can probably survive in the greenhouses. Only females and juveniles were collected, which implies that the Comenius University population of this species is probably parthenogenetic.

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Do really all wolf spiders carry spiderlings on their opisthosomas? The case of *Hygrolycosa rubrofasciata* (Araneae: Lycosidae)

Petr Dolejš

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Abstract. Wolf spider females are characterised by carrying cocoons attached to their spinnerets. Emerged spiderlings are carried on the females' opisthosomas, with the exception of three Japanese lycosid species who carry spiderlings on empty cocoons. Here, the same behaviour is recorded in a European spider: the drumming wolf spider *Hygrolycosa rubrofasciata*. Spiderlings of this species do not try to climb on the female's opisthosoma, even when they are adopted by a female of a species with a normal pulli-carrying behaviour. This behaviour occurs in Trechaleidae and four unrelated species of Lycosidae inhabiting wet habitats and is therefore regarded as an adaptation to the unsuitable environment.

Keywords: Cocoons, female abdominal knobbed hairs, humid habitats, pulli-carrying behaviour, spiderling clusters

Female wolf spiders are known for their care of both cocoons and spiderlings (Foelix 2011). They carry their cocoons attached onto the spinnerets (cocoon-carrying behaviour) and their spiderlings on the opisthosoma (pulli-carrying behaviour) (Fujii 1976). All lycosids show cocoon-carrying behaviour, there are, however, three exceptions concerning pulli-carrying. Fujii (1976) found that females of *Arctosa ebicha* Yaginuma, 1960 and *Arctosa fujiii* Tanaka, 1985 (sub *Lycosa* sp.) do not carry their spiderlings on the opisthosoma. Juveniles of these species stay for several hours on the cocoon surface and then disperse within one to four days (Fujii 1976). This behaviour is also typical for members of the putative sister family Trechaleidae, which also carry cocoons attached to the spinnerets like lycosids (Carico 1993). The same behaviour was also recorded for females of *Hygrolycosa umidicola* Tanaka, 1978 (Suwa in litt. 1977, Yaginuma 1991). Females of both *A. ebicha* and *A. fujiii* lack the abdominal knobbed hairs (Fujii 1983) that enable the spiderlings to climb onto the mother's opisthosoma (Rover et al. 1973). Kronstedt (1984, 1996) recorded that these knobbed hairs are also absent in females of *Hygrolycosa rubrofasciata* (Ohlert, 1865) and suggested that this may be associated with the pulli-carrying behaviour. Ahtiainen et al. (2002) noted that "the offspring (of *H. rubrofasciata*) usually remain on the female's abdomen or on top of the empty egg sac for a day to chitinise their exoskeleton, after which they disperse". Thus, this species was chosen for the present study to clarify its pulli-carrying behaviour.

Hygrolycosa Dahl, 1908 is still of uncertain subfamilial affinities. It belongs either to Piratinae (Zyuzin 1993) or Venoniinae (Murphy et al. 2006), and currently contains four species (Platnick 2013). The drumming wolf spider, *Hygrolycosa rubrofasciata* is a rare, Palearctic, Eurosiberian wolf spider inhabiting reed swamps, alder forests and marshy pine forests (Buchar & Růžicka 2002). It is a diurnal species (Kronstedt 1984, 1996), well known for its audible acoustic courtship behaviour (Helversen in: Rovner 1975, Kronstedt 1984, 1996, Köhler & Tembrock 1987) and for the lowest male diploid chromosome number ($2n\delta = 20$) among European wolf spiders (Gorlov et al. 1995). Both males and females mature in autumn (Kronstedt 1984) and it takes two or three years to complete their life cycle (Kotiaho et al. 1996, Vertainen et al. 2000). The life cycle is a transition between diplochronous – with mating periods in autumn and spring – and stenochronous with a mating period occurring only in spring (Braun 1976 and references therein). Males die during or immediately after the mating season (in spring); however, females can survive until the next mating season (Kotiaho et al. 1999). In northern Europe, females produce more than one cocoon (Vertainen et al. 2000), and in central Europe, females can make up to three cocoons per year (Dolejš pers. obs.). The cocoons contain about 60 eggs (Wiebes 1959). The pulli-carrying behaviour of this species has, however, not been thor-

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oughly investigated previously. Therefore, this study aims to investigate (1) the pulli-carrying behaviour of *H. rubrofasciata*, (2) the behaviour of *H. rubrofasciata* spiderlings on “substitute” mothers and “adoptive” spiderlings on *H. rubrofasciata* mothers after exchange of cocoons, and (3) the surface of the *H. rubrofasciata* cocoon in an attempt to determine the possible responsible structures for its pulli-carrying behaviour.

Methods

Females were collected at their first cocoon-carrying stage in the Kokořínsko Protected Landscape Area during a field course “Fauna of the Czech Republic”. There were six females collected at the locality Černý důl Natural Monument (50°29'N, 14°37'E; grid mapping square 5553; 310 m a.s.l.) on 10.5.2011, six females were collected at the locality Mokřady Horní Liběchovky Nature Reserve (50°31'N, 14°32'E; grid mapping square 5453; 260 m a.s.l.) on 11.5.2011, and two females were collected at the locality Jestřebské slatiny (50°36'N, 14°37'E; grid mapping square 5453; 250 m a.s.l.) on 23.5.2011 (lgt. Antonín Kůrka). Voucher specimens are deposited in the National Museum in Prague (N^os P6A 5070–5072).

Pulli-carrying behaviour was studied in the laboratory. In order to study differences in behaviour in test tubes and in simulated natural conditions, seven females were held in plastic test tubes (length 10 cm, diameter 15 mm) with cotton wool as a source of water and seven females were kept in four diagonally divided glass terraria (14 × 11 × 8 cm) with 3 cm of leaves. The programme NCSS 2007 (Hintze 2006) was used to test normality, to calculate descriptive statistics on the length of the pulli-carrying period, and to compare (Two-Sample T-Test) the length of the pulli-carrying period of females kept in test tubes with those kept in terraria.

After the females of *H. rubrofasciata* made the second cocoon, the behaviour of females with exchanged cocoons were tested. Cocoons of three females (in terraria) were replaced by cocoons of *Pardosa amen-tata* (Clerck, 1757), a species that displays a normal pulli-carrying behaviour (Vlijm et al. 1963). Three females of the latter species were collected at their second cocoon-carrying stage from Žleby (49°53'N, 15°29'E; grid mapping square 6158; 240 m a.s.l.). They were kept in terraria as described above for *H. rubrofasciata*. After the spiderlings of both species emerged from the cocoons, the behaviour of spider-

lings on their “adoptive” mothers was examined and documented (digital camera Olympus C-7070 WZ). In order to compare possible structural differences in cocoon surface, empty cocoons of both species were inspected under a scanning electron microscope JEOL 6380 LV.

Results

Pulli-carrying behaviour of *Hygrolycosa rubrofasciata*

After emergence from the cocoon, spiderlings of *H. rubrofasciata* did not climb onto the opisthosoma of their mother. Instead, they stayed on the surface of the cocoon (Fig. 1). Spiderlings of females kept both in terraria and test tubes behaved in the same way. However, time spent on the cocoon surface differed significantly in both groups ($p = 0.0031\%$). Spiderlings of females kept in terraria dispersed within 1–3 days ($\bar{X} = 2.29$, $SD = 0.756$, $n = 7$), but those of females kept in test tubes within 4–6 days ($\bar{X} = 5.00$, $SD = 0.816$, $n = 7$). In cases of larger clutch size, a few spiderlings stepped on the mother's opisthosoma using their forelegs, however they always remained in contact with the cocoon or with lower layer of spiderlings on the cocoon surface. Females detached their empty cocoons after the spiderlings had dispersed.

Behaviour of spiderlings on substitute females

All females (of both *H. rubrofasciata* and *P. amen-tata*) accepted, sooner or later, cocoons of the other species. After emergence, spiderlings of *H. rubrofasciata* did not try to climb on the opisthosomas of *P. amen-tata* females and remained on the cocoon surface (Fig. 2). By contrast, spiderlings of *P. amen-tata* tried to climb



Fig. 1: Pulli-carrying behaviour of *Hygrolycosa rubrofasciata*. Newly emerged spiderlings occupy the surface of the cocoon instead of climbing onto the opisthosoma of their mother.

onto the opisthosoma of *H. rubrofasciata* females, yet only few spiderlings were successful in settling on a substitute mother. The majority of spiderlings formed a cluster either beside the empty cocoon or on the ventral surface of the female's opisthosoma – in the area where the cocoon was touching the opisthosoma. Therefore, *H. rubrofasciata* females were carrying two 'pellets': the empty cocoon and the cluster of *P. amen-tata* spiderlings (Fig. 3). However, the females lost the clusters within the same day as the spiderlings emerged and the spiderlings dispersed the following day. Examination of the cocoon surfaces revealed no differences between the cocoon structures of both species (Figs 4, 5).



Fig. 2: Behaviour of *Hygrolycosa rubrofasciata* spiderlings on a substitute *Pardosa amen-tata* mother. The spiderlings remained on the cocoon surface and did not try to climb onto the female's opisthosoma.

Discussion

A generally accepted statement that females of all wolf spiders carry spiderlings on their opisthosomas was contested. Fujii (1976) was the first author to report "abnormal" behaviour in two *Arctosa* species which carried spiderlings on their cocoons instead of on their opisthosomas. Suwa (in litt. 1977) and Yaginuma (1991) reported similar behaviour for *Hygrolycosa umidicola*, and Kronestedt (1984) and Ahtiainen et al. (2002) suggested such a possibility in *Hygrolycosa rubrofasciata* too. In the present study, it was confirmed unequivocally that females of *H. rubrofasciata* do not carry spiderlings on their opisthosomas, but instead on their empty cocoons. Until now, this

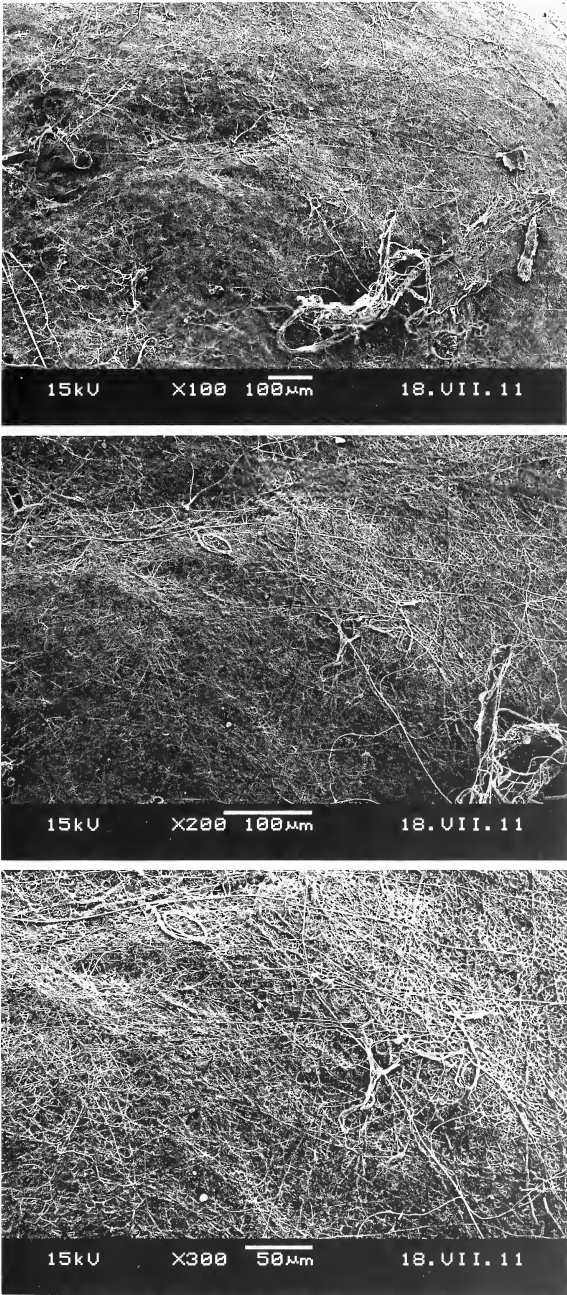


Fig. 3: Behaviour of *Pardosa amen-tata* spiderlings on substitute *Hygrolycosa rubrofasciata* mother. Most of the spiderlings were not successful in settling on the opisthosoma of a substitute female. Instead, they formed a cluster beside the empty cocoon. The female was carrying both the spiderling cluster and the empty cocoon for a while, until she lost the cluster.

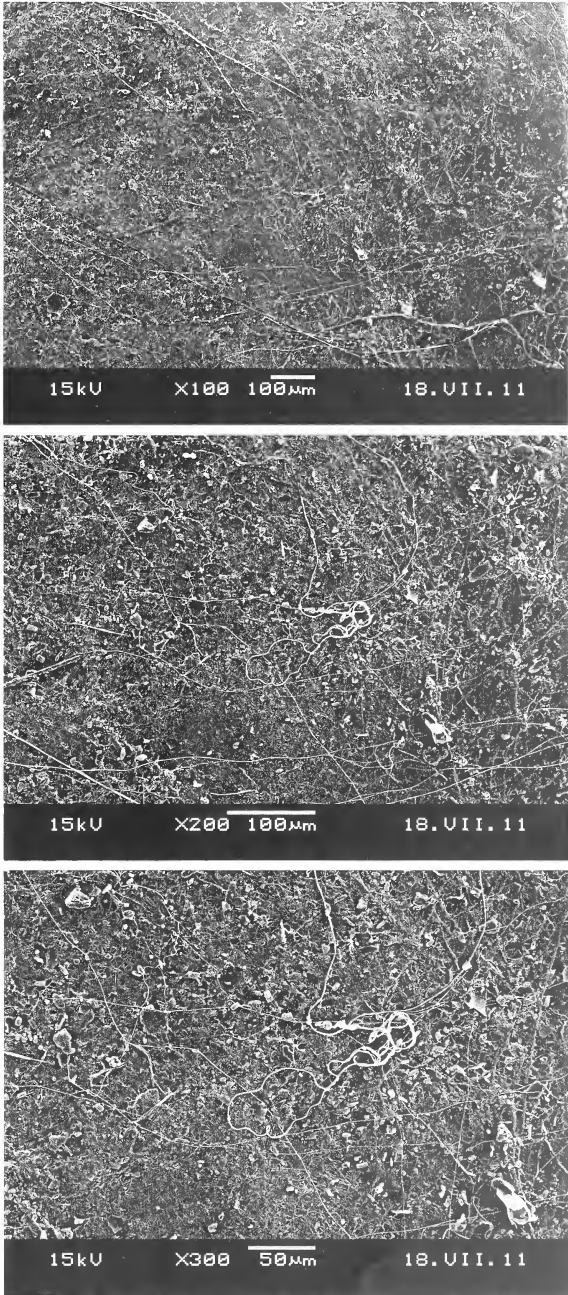
unusual behaviour was only known from four lycosid species: *A. ebicha*, *A. fujiii*, *H. rubrofasciata* and *H. umidicola*.

The time which the spiderlings spent on the cocoon surface differed between females kept in terraria and those in the test tubes. In natural conditions, the spiderlings probably disperse within two days – this is maybe the reason why pulli-carrying behaviour has not yet been observed in the field. In the test tubes, spiderlings probably did not have enough space to disperse and therefore remained longer on the cocoon surface. A similarly short pulli-carrying period was reported for *A. fujiii*, but three times longer for *A. ebicha* (Fujii 1976). However, the females of these species were kept in small glass vials and therefore the length of the period could be affected. There are no data about the length of pulli-carrying period in *H. umidicola*.

After cocoon exchange, spiderlings behaved on the substitute mother as they would on their own mother: *H. rubrofasciata* spiderlings remained on the cocoon surface, although they were carried by a *Pardosa* female. Similarly, *Pardosa* spiderling tried to climb on the *H. rubrofasciata* female, but only few of them were successful – presumably due to the absence of abdominal knobbed hairs. The majority of spiderlings tended to aggregate elsewhere. It seems therefore that the primary behaviour of the



Figs 4a-c: Cocoon surface of *Hygrolycosa rubrofasciata*. Scale bars: a) and b) 100 μ m, c) 50 μ m



Figs 5a-c: Cocoon surface of *Pardosa amentata*. Scale bars: a) and b) 100 μ m, c) 50 μ m

spiderlings is species-specific and does not depend on the mother. The same results were also obtained by Fujii (1980). He tested behaviour of *Pardosa as-trigera* L. Koch, 1878 which carry spiderlings normally on the opisthosoma, and *A. fujiii* (sub *Arctosa* sp.), which carry spiderlings on the cocoon (see Fu-

jii 1980: figs. 1G and 1H). Both *Pardosa* spiderlings failed to settle on the substitute mother (*A. fujiii*, *H. rubrofasciata*) and formed a cluster. This behaviour disagrees with observations in *Schizocosa crassipes* (Walckenaer, 1837) and *Rabidosa rabida* (Walckenaer, 1837) in which the spiderlings never clus-

tered when separated from their mothers (Higashi & Rovner 1975).

Spiderlings settle only on suitable surfaces (Engelhardt 1964, Rovner et al. 1973, Fujii 1983). Therefore, it is curious that there are no 'proper structures' on the cocoon surface of *H. rubrofasciata*. Unfortunately, only a few workers examined cocoon microstructure (e.g. De Bakker et al. 2006), but none of them considered lycosid and trechaleid cocoons. For this reason, it would be of value to study the mechanics underlying lycosid and trechaleid spiderling behaviour.

The clustering of spiderlings on an empty cocoon for a short time – instead of on their mother's opisthosoma – in *A. ebicha* and *A. fujiii* is peculiar because at least *A. ebicha* is related neither to the genus *Hygrolycosa* nor to other *Arctosa* species (Murphy et al. 2006), and probably belongs (together with the related *Arctosa kwangreungensis* Paik & Tanaka, 1986) to a separate, undescribed genus (Framenau in litt. 5. xii. 2007). Interestingly, members of *Hygrolycosa*, both *A. ebicha* and *A. fujiii*, and the most members of the family Trechaleidae live in very humid or even wet habitats (Tanaka 1978, 1991, Carico 2005). Little drops of water remaining on the opisthosomal surface and hairs probably create unsuitable conditions for clustering the spiderlings. The dragline threads eventually forming a layer over the surface and providing a good means of attachment for the spiderlings (Rovner et al. 1973) probably cannot be attached to the moist surface or hairs either. Moisture can even paste the knobbed hairs together and disable the spiderlings' ability to cling onto their mother's opisthosoma.

For this reason, the cocoon surface seems to be more water-repellent (Hieber 1984 in: Hieber 1992) and presents better place to cluster, despite the absence of any auxiliary structures. Fujii (1983) reported the absence of knobbed hairs, but normal pulli-carrying behaviour, in *Arctosa subamylacea* (Bösenberg & Strand, 1906) and *Arctosa depectinata* (Bösenberg & Strand, 1906). These two species live mainly in fields (Tanaka 1991) so clustering on the cocoon has not developed. On the other hand, Fujii (1980), who also tested spiderling behaviour after cocoon exchange in *Pardosa astrigera* and *Pirata subpiraticus* (Bösenberg & Strand, 1906), showed that spiderlings of *P. astrigera* climbed indeed onto the opisthosoma of wet-habitat-dwelling *P. subpiraticus* but all of them dropped from her till the next day and clustered elsewhere. Correspondingly, spiderlings of most of *Pirata* (and

Piratula) species do not mount the opisthosoma of the female, but remain in the silken retreat (Nielsen 1932). Therefore, living in wet habitats rather than lacking knobbed hairs seems to be the main reason for modifying pulli-carrying behaviour.

This contribution shows how little is known about basic biological data for wolf spiders. It is necessary to study the pulli-carrying behaviour and female abdominal knobbed hairs of other wet-habitat lycosids (*Hygrolycosa*, *Arctosa*, *Pirata*, *Piratula*) and trechaleids. As Fujii (1976) already stated, more data must be obtained to clarify the evolution of pulli-carrying behaviour in lycosids and related families.

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My great thanks belong to Hozumi Tanaka who informed me about the behaviour of *H. umidicola*, provided me with unpublished information from Masayoshi Suwa, and encouraged me to study *H. rubrofasciata*. I would like to thank the participants of the field course "Fauna of the Czech Republic", namely Lucie Jarošová, who collected females of *H. rubrofasciata* in Kokořínsko PLA, and to Antonín Kůrka who collected them at Jestřebské slatiny. I wish to thank Volker W. Framenau for providing me with his unpublished data. I am indebted to Jan Buchar and Hozumi Tanaka for valuable discussion and critical reading of the manuscript. I also thank Torbjörn Kronestedt and an anonymous reviewer for important comments and valuable suggestions that improved the earlier version of the manuscript. This work was financially supported by Ministry of Culture of the Czech Republic (DKRVO 2013/13, National Museum, 00023272).

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Bestätigung von *Homalenotus quadridentatus* (Opiliones: Sclerosomatidae) für die Fauna Deutschlands

Antje Deepen-Wieczorek & Axel L. Schönhofer

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Abstract. Confirmation of *Homalenotus quadridentatus* (Opiliones: Sclerosomatidae) for the fauna of Germany. The sclerosomatid harvestman *Homalenotus quadridentatus* (Cuvier, 1795), long known close to the border of Germany, is hereby confirmed for the country. Several specimens were observed and collected in a small urban garden area in the town Aachen, suggesting a considerable population. The finding is briefly discussed, and general remarks on the distribution, ecology and conservation of the species are provided.

Keywords: Central Europe, first record, Germany, harvestmen, oceanic climate

Bereits in der Bearbeitung der mitteleuropäischen Fauna wies Martens (1978) auf die grenznahen Nachweise des in Westeuropa weit verbreiteten Sclerosomatiden *Homalenotus quadridentatus* (Cuvier, 1795) und damit auf die Wahrscheinlichkeit seines Vorkommens in Deutschland hin. Stabile Vorkommen waren zu diesem Zeitpunkt aus Süd-Limburg (Niederlande) bekannt (Spoek 1957, 1975), mit einigen Fundpunkten nur 5 km von der niederländisch-deutschen Grenze entfernt. In weiser Voraussicht wurde bereits eine deutsche Nachweiskarte für *Homalenotus quadridentatus* vorbereitet (Staudt 2013) und tatsächlich wurde die Art bereits von Petto (1991) aus dem Itterbachtal südöstlich Aachens gemeldet, der Nachweis Mangels prüfbarer Belege allerdings nicht in deutsche Faunenlisten übernommen (T. Blick in litt.). Im November 2012 gelangen nun eindeutige Nachweise von *H. quadridentatus* (Abb. 1) auf deutschem Gebiet, in einem Aachener Garten. Sie werden nachfolgend dokumentiert und diskutiert.

Fundort, Material und Methoden

Der Fundort aller Tiere ist ein privater Garten: Deutschland, Nordrhein-Westfalen, Aachen, Brand, Niederforstbach, Münsterstr. 207, 248 m ü. N.N. (WGS84: 50,7395°N, 5,1583°E, TK25: 5202). Im Zeitraum vom 9. November bis Ende November 2012 wurden täglich ein bis zwei Exemplare durch manuelle Suche nachgewiesen, am 9. und 28.11. sogar vier Exemplare (Fotobelege mit Panasonic

Lumix G2 mit Leica DG Macro-Elmarit 1:2.8/45 asph. vom 9., 12., 14., 18., 20. und 30.11.). Von diesen wurden zwei Männchen am 20.11.2012 als Belege in 70 % EtOH konserviert und in der Sammlung Schönhofer unter der Nummer 1534 archiviert (Abb. 1A). Zwei Exemplare wurden vom 18. bis 28.11. in mit Erde, Steinen und Rindenstückchen ausgelegten Petrischalen beobachtet. Die Binokularaufnahme wurde mit einem Wild-Heerbrugg M5A und einer Nikon D90 (Weitwinkelobjektiv mit Retroadapter) erstellt. Die Determination erfolgte nach Martens (1978) und Wijnhoven (2009), siehe dort weitere Informationen zur Spezies.

Geografische Einordnung des Fundortes und Anmerkungen zum Areal

Nach Durchsicht der relevanten Literatur bleibt, bis auf die neuen Nachweise aus den Niederlanden (Noordijk & Wijnhoven 2009, Wijnhoven 2009) und Deutschland, das von Martens (1978: Abb. 747) grob umrissene Verbreitungsgebiet aktuell (Abb. 2). Probleme ergeben sich aber mit der Zuordnung von *Homalenotus*-Nachweisen am südlichen Arealrand. So wurde *H. quadridentatus* auch für die Südost- und Südwestküste der Iberischen Halbinsel gemeldet (Rambla 1960, 1967) – Angaben, die bereits Martens (1978) nicht übernahm. Es sei hier auf die Schwierigkeiten bei der Abgrenzung der südeuropäischen *Homalenotus*-Arten hingewiesen, die eine Zuordnung von Literaturnachweisen ohne Sichtung des Materials nicht immer zweifelsfrei erlaubt. Nördlich der Pyrenäen scheint *H. quadridentatus* hingegen die einzige Art der Gattung zu sein.

Nicht abschließend geklärt scheint auch der genaue Verlauf der östlichen Arealgrenze von *Homalenotus quadridentatus*, die sich im Süden Frankreichs

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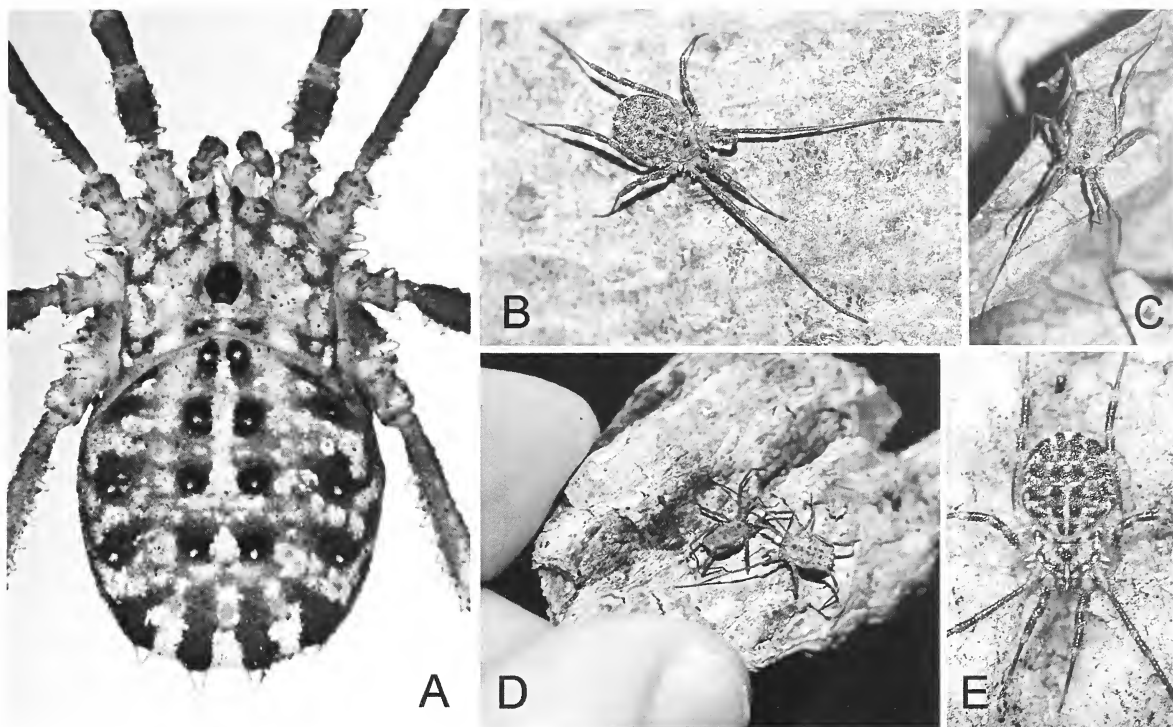


Abb. 1: *Homalenotus quadridentatus*. A. Männchen von dorsal; B-D. Adulte Exemplare unbestimmten Geschlechts; E. Subadultes Exemplar.

Fig. 1: *Homalenotus quadridentatus*. A. Male, dorsal view; B-D. Adult specimen of unknown gender; E. Subadult specimen.

etwa entlang der Grenze zu den Alpen hinzieht (Lessert 1917: Dép. Haute-Savoie: Gaillard, Petit-Salève; Delfosse 2004: Dép. Isère: Le Sappey, Dép. Alpes-de-Haute-Provence: Digne-les-Bains) und in der Schweiz ab dem Genfer See am Nordalpenrand bis knapp östlich Luzern (Lessert 1917: Weggis; Becker 1896: Vallée de la Reuss) vordringen soll. Martens (1978) bezieht diese östlichsten Schweizer Funde als wahrscheinlich zu unsicher, nicht in seine Verbreitungskarte mit ein. Nördlich davon lässt sich keine genaue Ostgrenze ziehen. Es scheint jedoch bisher keine Funde in den Vogesen oder östlich davon zu geben. Eine Einwanderung über eine Südroute nach Deutschland ist wegen der dazwischen liegenden Gebirgskzüge mit für *Homalenotus* ungünstigerem Klima weniger wahrscheinlich. Nennungen des südwesteuropäischen *Homalenotus monoceros* C.L. Koch, 1839. aus Süddeutschland (Hoc 1966: Regensburg) beruhen sicher auf Verwechslungen.

Betrachtet man die weitere Verbreitung der Art, so fügt sich der Fundort bei Aachen fast nahtlos an die bisher bekannte Verbreitung und vor allem an die schon länger bekannten Vorkommen in Limburg an.

Mit dem Nachweis von *Homalenotus quadridentatus* steigt die Zahl der in Deutschland im Freiland vorkommenden Weberknechtarten auf 52 (Muster et al. im Druck).

Ökologie

Der Fundort zeichnet sich durch dichte Krautschicht, Grasbewuchs durchsetzt mit Stauden wie z.B. Goldrute aus und liegt im Bereich eines mit Efeu überwachsenen Wiesen-Weidenzauns. Ein künstlich angelegter Teich sorgt für höhere Bodenfeuchtigkeit. Die Tiere wurden hier vorwiegend unter flachen Steinen aufgefunden, und sind aufgrund ihrer Tarnung mit Erde oft schwer zu entdecken. Als Begleitarten wurden im Jahre 2012 beobachtet: *Opilio canestrinii* (Thorell, 1876) (23.12.–24.12.: 1 juv.; 2.11.: 7 Ex.), *Paroligolophus agrestis* (Meade, 1855) (21. und 29.11.: 4♀♀), *Nemastoma dentigerum* Canestrini, 1873 (22.12.–23.12.: 6 ad.), *Rilaena triangularis* (Herbst, 1799) (14. und 16.11.: 12 juv.). Die weitere Umgebung ist vorwiegend landwirtschaftlich genutzt, in der Nähe befindet sich ein aufgelassener und mit Wald bestandener Kalksteinbruch, was in

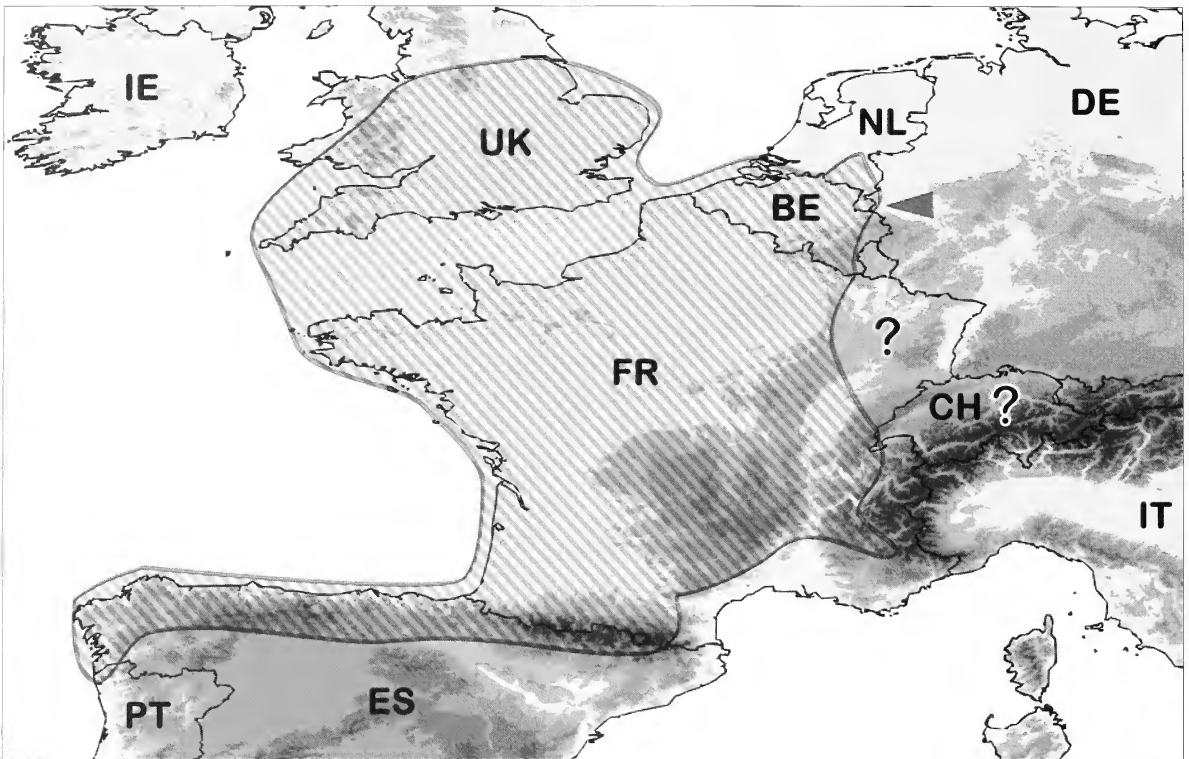


Abb. 2: Verbreitung von *Homalenotus quadridentatus* basierend auf Martens (1978) und modifiziert nach Delfosse (2004), Noordijk & Wijnhoven (2009), Vanhercke (2004), Wijnhoven (2009) und dem hier publiziertem Nachweis. Der Pfeil zeigt den Fundort in Deutschland. Fragezeichen zeigen unsichere Schweizer Fundorte nach Becker (1896) und Lessert (1917) und die nicht geklärte Verbreitungsgrenze in Frankreich. Abkürzungen nach Internationalem Ländercode.

Fig. 2: Distribution of *Homalenotus quadridentatus* based on Martens (1978) and modified according to Delfosse (2004), Noordijk & Wijnhoven (2009), Vanhercke (2004), Wijnhoven (2009) and the record herein. The arrow indicates the locality in Germany. Question marks indicate problematic Swiss records according to Becker (1896) and Lessert (1917) and the unverified distribution border in France. Abbreviations follow international country code.

etwa den Fundorten in Limburg entspricht. Noordijk & Wijnhoven (2009) fanden die Art mehrfach in Ackerrandstreifen (Seeland, Niederlande). Petto (1991) meldete 24 Individuen gefangen mit Bodenfällen in Gehölzstrukturen des Itterbachtals.

Die regelmäßig erbrachten Nachweise von *Homalenotus* aus einem kleinflächigen urban-anthropogen geprägten Lebensraum, sowie die durch unsere Funde wahrscheinlich zu bestätigenden Nachweise von Petto (1991, ebenfalls TK 5202), lassen auf eine relativ stabile Population im Raum Aachen schließen. Trotz des lokalen Nachweises halten wir eine Gefährdung daher für unwahrscheinlich.

In Gefangenschaft nahm *Homalenotus quadridentatus* verschiedene Wirbellose (Annelida, Acari, Isopoda, Diptera, Collembola, Diplopoda, vorwiegend frisch getötet) als Nahrung an. Gelegentlich wurde ein Abbürsten abgestorbener Blätter mit den

Palpen beobachtet. Bei Kontaktaufnahme betasteten sich die Tiere mit den Vorderbeinen. In Ruhephasen saßen sie beieinander, hielten aber Individualabstand ohne Kontakt. Teilweise wurde kräftiges Hakeln mit den Beinen oder Wegschieben eines anderen Tieres beobachtet.

Ausbreitung und Ausblick

Die von Noordijk & Wijnhoven (2009) und Wijnhoven (2009) berichteten, rezenten Funde von *Homalenotus quadridentatus* verschieben die vormalig bekannte Verbreitungsgrenze der Art innerhalb der Niederlande (Süd-Limburg) scheinbar deutlich nach Norden. Zusammen mit den Funden in Aachen stellt sich die Frage, ob auch dieser Weberknecht sein Areal aktuell erweitert. Arten für die eine deutliche Expansion anzunehmen ist, sind beispielsweise *Nemastoma dentigerum*, *Odiellus spinosus* (Bosc, 1792), *Astrobus laevipes*

(Canestrini, 1872) und *Nelima sempronii* Szalay, 1951. Diese Arten des kontinentalen oder mediterranen Verbreitungstyps besiedelten in Deutschland zuerst lokale, kontinental geprägte Wärmeinseln (Stand Martens 1978) und breiteten sich in den letzten Jahrzehnten, wahrscheinlich im Zuge der Erwärmung, sehr deutlich aus (vgl. Staudt 2013).

Homalenotus quadridentatus hingegen besiedelt den ozeanisch geprägten Raum, der durch relativ kühle Sommer, milde Winter und ganzjährigen Niederschlag charakterisiert ist (vgl. Heinze & Schreiber 1984). Die Jahresdurchschnittstemperatur in Aachen-Brand liegt bei 10 °C, die minimale Tagesdurchschnittstemperatur bei -12,2 °C, und ist damit im deutschen Vergleich sehr gemäßigt (siehe <http://www.wetter-aachen-brand.de>). Auch der am Fundort nachgewiesene *Paroligolophus agrestis* besitzt ein mit dem atlantischen Klimaeinfluss korrespondierendes Areal, dringt allerdings deutlich weiter in den kontinentalen Bereich als *Homalenotus* (Martens 1978). Im Vergleich mit den kontinental-mediterranen Arten ist daher nicht von einer starken rezenten Ausbreitung von *Homalenotus* auszugehen. Auch die neuen Funde schließen wahrscheinlich lediglich bestehende Nachweislücken, die weitere Funde entlang der niederländischen Grenze (Noordijk & Wijnhoven 2009, Wijnhoven 2009) und in Luxemburg (Vanhercke 2004) möglich erscheinen lassen. Auch das unveränderte *Homalenotus*-Areal in England (British arachnological Society 2013) spricht nicht für eine rezente Ausbreitung der Art.

Danksagung

Die gemeinschaftliche Bestimmung oder Bestätigung der Weberknechte erfolgte auf <http://insektenfotos.de/forum> zusammen mit Katrin Jäckel, Arp Kruithof und Jörg Pageler, wofür wir uns herzlich bedanken. Theo Blick ermöglichte die unkomplizierte und kompetente Betreuung des Manuskripts. Wertvolle Kommentare steuerten Peter Bliss (Halle/Saale) und ein anonymes Gutachter bei.

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A tropical invader, *Coleosoma floridanum*, spotted for the first time in Slovakia and the Czech Republic (Araneae, Theridiidae)

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Abstract. The pantropical theridiid spider *Coleosoma floridanum* Banks, 1900 was recorded for the first time in Slovakia and in the Czech Republic. Both sexes and juveniles were collected in some numbers in heated greenhouses with high humidity. A description and photographs of the species are provided.

Keywords: botanical garden, comb-footed spider, faunistics, first record, greenhouse, introduced species

The small genus *Coleosoma* consists of nine tropical species distributed mostly in the Indo-Malayan ecozone (Platnick 2012). Except for the largest species, *C. matinikum* Barrion & Litsinger, 1995 – known only from males, with a total length of ca. 4.8 mm – the remaining species are of small size (ca. 2 mm). They are thus easily accidentally imported to other countries on plants carried by ships. Despite this fact, only *C. floridanum* has so far spread to Europe. This species is commonly found in packages arriving from tropics, thus it has been exported over the globe and may be expected to occur in any sort of tropical greenhouse. The type locality for *C. floridanum* is situated in Florida; the species was also found on many islands in the Caribbean, inferring that the Neotropical region is probably its place of origin. However, some authors pointed out that the Oriental region should be considered instead due to the presence of its related species there (Levi 1967, Spoczynska 1969).

Species of this genus have a distinct sexual dimorphism. Females have a basically oval abdomen, in some species protruding as a tubercle above the spinnerets (*C. acutiventer* (Keyserling, 1884), *C. blandum* O. P.-Cambridge, 1882).

Methods

Specimens were collected in the greenhouses of botanical gardens in Bratislava, Brno and Prague. They were collected predominantly (ca. 90 %) on the un-

derside of plant leaves; some of them (ca. 10 %) were extracted from soil samples using Tullgren funnels. They were identified using Nentwig et al. (2012) and compared to the original description (Banks 1900) and to the other species of the genus through the detailed description and figures provided by several authors, e.g. Bryant (1940, 1944), Levi (1959), Barrion & Litsinger (1995) and Saaristo (2006).

Microphotographs were made using EOS Utility software and a digital camera (Canon EOS 1100D) connected to a Zeiss Stemi 2000-C stereomicroscope. Microslides of epigynes were photographed using a Leica ICC50 camera connected to a Leica DM1000 stereomicroscope using LAS EZ 1.8.0. Digital images were combined using CombineZP image stacking software. Description of the species is based on all mature specimens obtained in Slovakia. All measurements are in millimeters, and were obtained using AxioVision 4.8.2; M = median, x = arithmetic mean. Material is deposited in 70 % ethanol in the collections of the first and the last author.

Results and discussion

Coleosoma floridanum Banks, 1900

The species has been described under various names; a list of junior synonyms is given below. Many of them were recognized by Levi (1959), although he also pointed out that there should be further synonyms within the genus *Theridion*.

Theridion interruptum Banks, 1908: 205, fig. 9 (described ♀). (Bryant 1944)

Bathypantes semicincta Banks, 1914: 640 (undefined sex). (Levi 1972)

Lithyphantes oophorus Petrunkevitch, 1930: 170, fig. 8–9 (described ♀). (Levi 1959)

Theridion debile Petrunkevitch, 1930: 206, fig. 53–56 (described ♀). (Levi 1959)

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Theridion rapanae Berland, 1942: 15, fig. 6a–f (described ♂♀). (Levi 1959)

Theridium albobittatum Caporiacco, 1955: 334, fig. 25a–c (described ♀). (Levi 1959)

Theridion aleipata Marples, 1955: 483, pl. 58, fig. 9, 13, 19 (described ♂♀). (Levi 1959)

Coleosoma saispotum Barrion & Litsinger, 1995: 432, fig. 258a–l (described ♂). (Knoflach 1999)

Theridion anthaeae Barrion & Litsinger, 1995: 447, fig. 268a–d (described ♀). (Knoflach 1999)

For the full list of references, see Platnick (2012).

Material examined

SLOVAKIA: 1♂ (22.XI.2012); 13♀♀, 2♂♂, 3subad♂♂, 5juv (12.XII.2012) Bratislava, greenhouse, Botanical Garden of the Comenius University (average temperature 26 °C), 48°8'49.2"N; 17°4'20.97"E, 148 m a.s.l. (grid square 7868, Fig. 1); leg. J. Christophoryová, M. Holecová, K. Krajčovičová & A. Sestáková.

CZECH REPUBLIC: 1♂, 25♀♀, 16juv (21.XI.2006) Brno, greenhouse, Botanical Garden and Arboretum of Mendel University (average temperature 26 °C), 49°12'57"N, 16°36'52"E, 245 m a.s.l. (grid square 6765, Fig. 1), leg. S. Korenko, E. Liznarová & L. Sentenská.

1♂ (3.IV.2012) Prague, greenhouse, Prague Botanical Garden (average temperature 26 °C/23 °C – day / night) 50°07'20"N, 14°24'50"E, 248 m a.s.l. (grid square 5852, Fig. 1), leg. S. Korenko & B. Korenková.

Diagnosis

The male can be easily distinguished from the other males of the genus by an oval and markedly narrower bulbous with a shorter semi-circular embolus – this is nearly circular in the other species – and by a projecting terminal apophysis. Unlike other species, the constriction of the male abdomen is indistinct. Females have a much simpler vulva with short ducts and a markedly wider atrium than those of other species.

Description

Male: Total length 1.67–1.94 (M = 1.73; x = 1.77), tibia + patella I 0.96–1.12 (M = 1.10; x = 1.06).

Males are ant-mimics. Carapace pale without markings, dark bordered. Sternum pale with dark narrow hem. Abdomen oval, more than twice as long as wide, with slight median constriction; anteriorly stridulating, sclerotized scutum protruding into blunt, bilobate projection over carapace, with two long setae; the scutum continues ventrally half the length of the abdomen. Colouration pale, distally black; dorsally in the middle with irregularly distributed white spots and two longitudinal black stripes. Legs long, thin, yellow; distal end of tibia IV black, in some specimens all other tibiae distally dark (Fig. 2). Bulbus oval, longer than wide; projecting strongly-sclerotized terminal apophysis; embolus filiform and semicircular (Fig. 4).

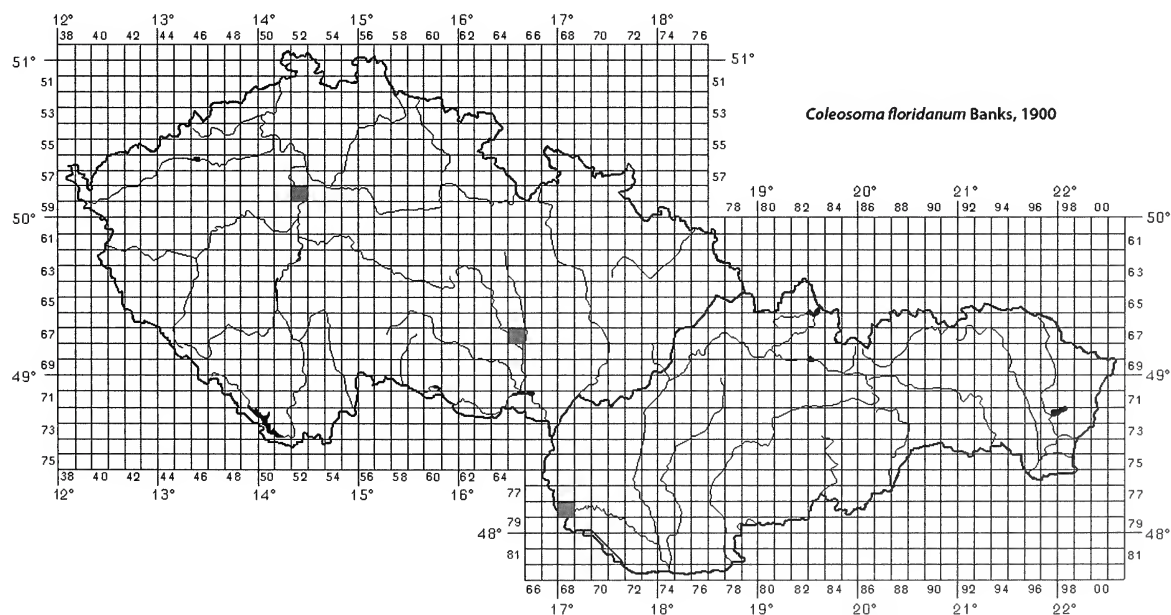


Fig. 1: Distribution map of *Coleosoma floridanum* in Slovakia and the Czech Republic.

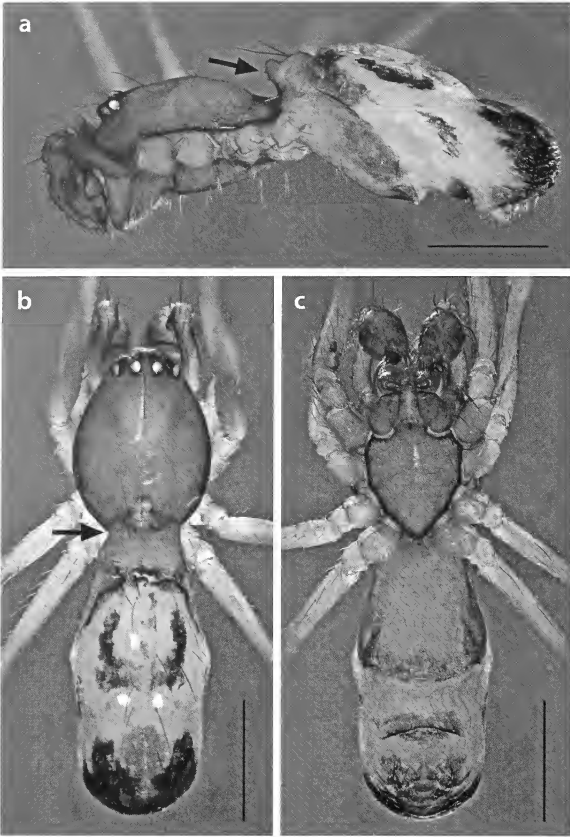


Fig. 2: Male habitus of *Coleosoma floridanum* from Slovakia. a) lateral, b) dorsal and c) ventral view. Arrows point to the bilobate sclerotization of the abdomen (Scale = 0.5 mm).

Female: Total length 1.34–1.87 ($M = 1.62$; $x = 1.60$), tibia + patella I 0.84–1.07 ($M = 0.96$; $x = 0.96$).

Female with similar colouration to the male, but paler. Abdomen globular, pale; dorsally with irregular white spots and two longitudinal interrupted stripes reaching spinnerets; ventrally transverse black spot above spinnerets. Legs yellow with dark distal end of femur and tibia, mostly visible on the first and fourth pair of legs (Fig. 3). Epigyne weakly sclerotized, semitransparent; wide, transverse epigynal atrium; spermathecae visible through cuticle, vulva with relatively short copulatory ducts (Fig. 5).

Records in Europe

In September 1964, specimens of *C. floridanum* were collected in Europe for the first time by Clark in the heated greenhouse of the Kew Botanical Garden in Britain. This record was published seventeen years later by Hillyard (1981). The first published record of the species in Europe is by Spoczynska (1969), who

collected in the same greenhouse in Britain on the 14.IX.1966. Additional first records from other European countries are summarized in Tab. 1.

Tab. 1: Current distributions and the first records of *Coleosoma floridanum* in Europe.

State	Date of collection	Reference of the first record
Austria	29.VIII.1999	Knoflach (1999)
Czech Republic	21.XI.2006	present work
Finland	26.II.1990	Koponen (1990)
France	10.VIII.2006	Emerit & Ledoux (2008)
Germany	I.1995	Broen et al. (1998)
Great Britain	IX.1964	Hillyard (1981)
Slovakia	22.XI.2012	present work
Switzerland	19.III.1999	Knoflach (1999)
The Netherlands	8.II.1995	Heldsingen (1995 & pers. comm.)

Natural history

Coleosoma floridanum is a pantropical species. It seems to be native to the American tropics (especially the Caribbean biozone). It has also been recorded from Africa (Ghana, Togo, Seychelles), India, Polynesia, New Hebrides, Hawaii, Galapagos Isl., Taiwan, Japan and China (Levi 1967, Spoczynska 1969, Saaristo 1978, Tanikawa 1991, Knoflach 1999). European populations are strictly synanthropic, being recorded from highly humid and heated greenhouses (about 20–30 °C) where they can occur in high numbers (Saaristo 2006). Similarly to natural populations, they occupy analogous microhabitats such as crevices in walls and tree bark, under stones, beneath abandoned dry flowerpots and on vegetation (Cutler 1972, Platen & Broen 2005). Spoczynska (1969) observed tiny webs – no more than 8 mm in diameter – usually on the base of leaves; however she found the majority of specimens outside their webs. The egg sac (Fig. 3c) is attached to the spinnerets and guarded by the female until hatching; the few eggs (ca. 10–12) are sparsely wrapped in white threads (Knoflach 1999).

We observed numerous specimens under the leaves of plants. Some were between stones and under the flowerpots, and only few specimens were collected within the soil. Our records are thus consistent with known natural history patterns described by several authors (e.g. Levi 1967, Cutler 1972, Platen & Broen 2005, Harvey et al. 2002).

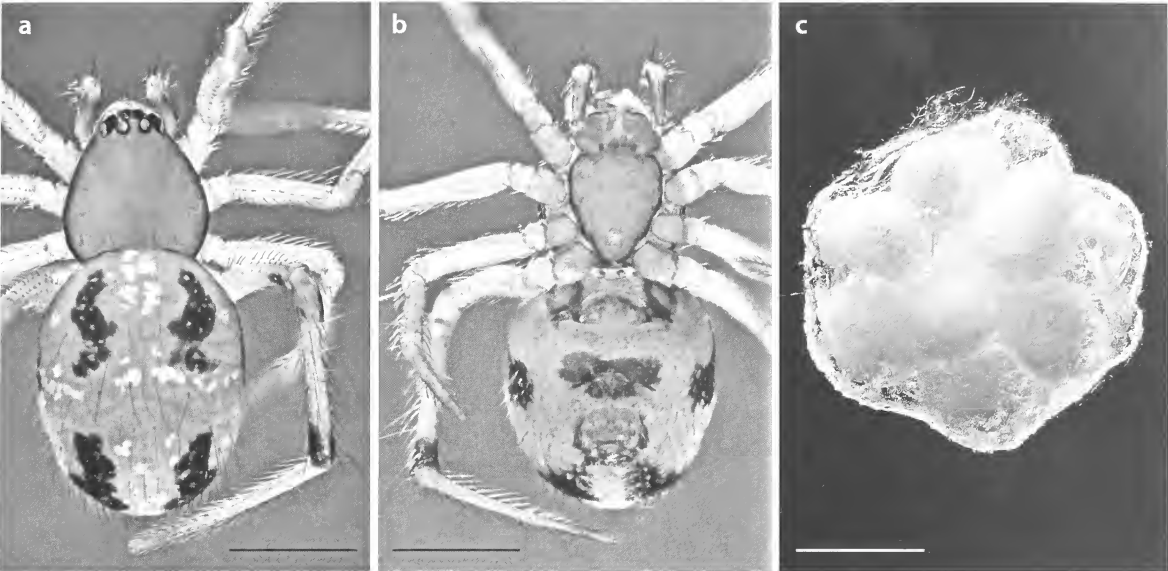


Fig. 3: Female habitus of *Coleosoma floridanum* from Slovakia, and its cocoon. a) dorsal and b) ventral view, c) cocoon (Scale = 0.5 mm).

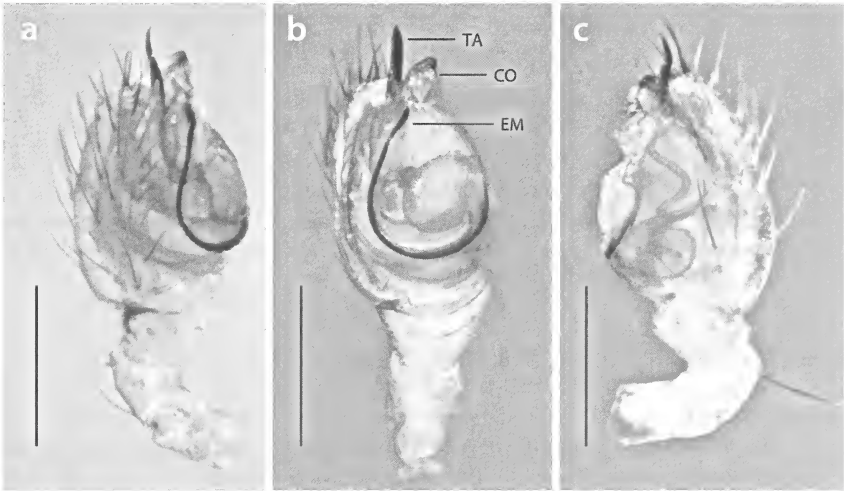


Fig. 4: Male palp of *Coleosoma floridanum* from Slovakia. a) prolateral, b) ventral and c) retrolateral view (Scale = 0.2 mm). CO = conductor; EM = embolus; TA = terminal apophysis.

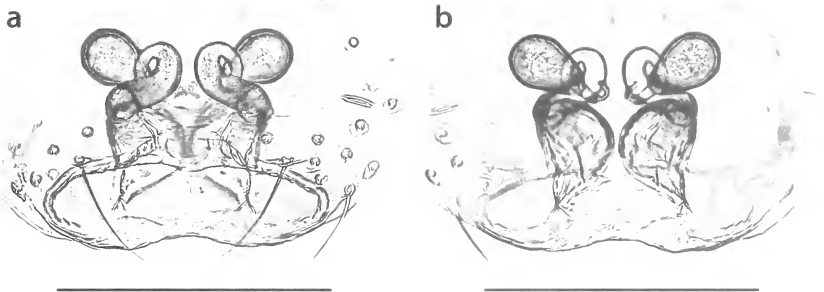


Fig. 5: Epigyne of *Coleosoma floridanum* from Slovakia. a) external and b) internal view (Scale = 0.2 mm).

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Spider records from East Macedonia and Thrace (NE Greece)

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Abstract. The present study summarises spider records from East Macedonia and Thrace (NE Greece). Spiders were mainly collected by hand sampling and to a smaller extent by pitfall trapping during field trips in 2002, 2004, 2007, 2008 and 2009. 171 species from 23 families were sampled. *Pelecopsis pavida* (O. P.-Cambridge, 1872) (Linyphiidae) and *Xysticus kaznakovi* Utochkin, 1968 (Thomisidae) were new to the European spider fauna and ten further species, *Diaea livens* Simon, 1876, *Heriaeus graminicola* (Doleschall, 1852), *Meioneta resilli* Wunderlich, 1973, *Oedothorax retusus* (Westring, 1851), *Philodromus albidus* Kulczynski, 1911, *Pocadicnemis pumila* Keyserling, 1880, *Sitticus saltator* (O. P.-Cambridge, 1868), *Stemonyphantes lineatus* (Linnaeus, 1758), *Synageles scutiger* Prószyński, 1979 and *Thanatus coloradensis* Keyserling, 1880, could be added to the Greek fauna for the first time. 21 and 38 species were new to East Macedonia and Thrace, respectively. Based on previous work, plus the present study, the Greek spider fauna now includes 1,108 species.

Keywords: Araneae, Balkan, Nestos, Thassos

The Balkan Peninsula is a biodiversity hotspot (Hubenov 2004, Krystufek & Reed 2004, Popov & Fet 2007) which comprises a very species rich spider fauna (Deltchev 1999, 2005). Northern Greece – part of the Balkan Peninsula – is situated in the transition zone of the European, Mediterranean and the Ponto-Anatolian biogeographical regions, which results in a high biodiversity (Jerrentrup et al. 1989, Schröder et al. 2011). Despite an increasing number of faunistic surveys (Buchholz 2007, Van Keer et al. 2010, Schröder et al. 2011) as well as taxonomic works (for an extensive compilation see Bosmans & Chatzaki 2005 and Van Keer et al. 2010) the spider fauna of Northern Greece, and especially Thrace, is still poorly investigated and thus remains underestimated (Chatzaki 2008). The present study summarises spider data which were recorded in the Eastern part of Northern Greece, namely East Macedonia and Thrace, and thus is intended to enhance current knowledge concerning spider distribution in this region.

Study area

Data were collected in the region of East Macedonia (prefectures Drama, Kavála, Thassos) and Thrace (prefectures Evros, Rhodopi, Xanthi) (Tab. 1, Fig. 1) which are situated in the north-eastern part of Greece and separated by the Nestos river. The study area is

delimited by the Bulgarian border to the north and the Turkish border or Evros river to the east, while the coastline of the Thracian Sea forms the southern border.

The northern part of north-east Greece is characterised by mountain ranges such as the Greek Rhodope massif along the Greek–Bulgarian border reaching altitudes of about 1950 m above sea level as well as the Pangaion, Menoikon, Lekani and Falakron mountains; the latter reaches the highest altitudes (2232 m a.s.l.). Towards the east, a lower mountainous area with altitudes not exceeding 650 m a.s.l. exists in the area of the Dadia nature reserve. In a southern and south-eastern direction the landscape becomes gradually lower and, via a belt of cultivated land, changes into the coastal plain of the Aegean Sea. Near the coast the landscape is formed by level to slightly undulated lowlands about 20 m above sea level. In the study area two rivers (Nestos, Evros) form deltas which are largely cultivated, but also still contain many natural habitats such as lagoons, salt marshes and remnants of floodplain forests. The Nestos delta includes the lagoon areas of Keramotí and Agiasma, and the eastward situated Lakes Vistonis and Mitrikou form the east Macedonian–Thracian wetland belt, which comprises a considerable number of natural lagoons and salt marshes.

The climate of the coastal plains is Mediterranean, although continental impacts become effective. Impacts manifest themselves as huge fluctuations in yearly temperature, with summer maxima of 40 °C

Tab. 1: Geographical information on the sampling localities.

No.	N	E	m a.s.l.	Location /Area	Region	Prefecture
1	41°18'01.36"	24°04'42.31"	1950	Falakron	East Macedonia	Drama
2	41°00'46.62"	24°17'03.30"	70	Philippi	East Macedonia	Kavála
3	41°02'51.14"	24°38'41.66"	190	Stenopos	East Macedonia	Kavála
4	40°51'13.53"	24°43'30.33"	0	Nestos Delta	East Macedonia	Kavála
5	40°50'58.25"	24°47'48.94"	0	Nestos estuary	East Macedonia	Kavála
6	40°46'40.86"	24°43'12.16"	120	Thassos	East Macedonia	Thassos
7	41°00'27.72"	24°42'24.39"	20	Aladjagiola	East Macedonia	Kavála
8	41°01'37.76"	24°38'04.75"	360	N Zarkadia	East Macedonia	Kavála
9	41°05'49.18"	24°45'10.85"	60	Nestos canyon	Thrace	Xanthi
10	41°08'56.73"	24°42'18.21"	460	Ano Livera	Thrace	Xanthi
11	41°06'57.70"	24°44'52.37"	760	Galani/Nestos view	Thrace	Xanthi
12	41°08'46.16"	24°53'04.24"	160	N Xanthi	Thrace	Xanthi
13	41°15'58.72"	24°48'45.96"	430	W Oreo	Thrace	Xanthi
14	41°02'00.92"	25°04'16.25"	20	Nea Kessani	Thrace	Xanthi
15	41°00'29.09"	25°08'48.95"	0	Lake Vistonis	Thrace	Xanthi
16	40°59'28.32"	25°18'23.91"	10	Lake Mitrikou	Thrace	Rhodopi
17	41°00'30.27"	25°07'13.74"	0	Porto Lagos	Thrace	Xanthi
18	41°00'12.62"	25°10'29.98"	5	SW Glykoneri	Thrace	Rhodopi
19	41°08'23.80"	25°12'37.69"	40	Kompsatos river	Thrace	Rhodopi
20	41°17'56.73"	26°01'16.01"	350	Roussa	Thrace	Evros
21	41°07'19.97"	26°13'40.10"	100	Dadia	Thrace	Evros



Fig. 1: Map of study area and location of sampling sites in East Macedonia (west of the Nestos river) and Thrace (east of the Nestos river) (pale area = lowland, grey area = mountain range). For further geographical information see Tab. 1.

and winter minima of -20°C . The annual average amount of precipitation is 600–700 mm (Jerrentrup et al. 1989), whereas the average annual temperature is 11°C (Lienau 1989). The climate of the mountain ranges shows typical Central European characteristics with snow from November to May (Volpers 1988). The potential natural vegetation along the coast is the Ostryo-Carpinion followed by Quercion frainetto-zone up to altitudes of 1000 meters above sea level (Horvat et al. 1974). At about 1000 meters the oak-zone changes into a beech-zone with spruce (*Picea abies*) and fir (*Abies*) (Volpers 1988, Lienau 1989).

Methods

Spiders were mainly collected by hand sampling and to a lesser extent by pitfall traps during field trips in 2002, 2004, 2007, 2008 and 2009. A broad variety of habitat types were sampled in 21 locations in East Macedonia and Thrace (Tab. 1, Fig. 1). Nomenclature and information on zoogeographical distribution of species were taken from Helsdingen (2012) and Platnick (2013) and more detailed literature on local elements. Bosmans & Chatzaki (2005), Buchholz (2007), Chatzaki (2008), Bosmans (2009), Bosmans et al. (2009), Van Keer et al. (2010) and Schröder et al. (2011) were consulted to identify those new records (indicated by 'nr' in Tab. 2) that the present study added to the list of known species in Greece, Macedonia and Thrace. By contrast, the '+' sign in Tab. 2 indicates species that were already recorded in the area.

Results and discussion

In total, 171 species from 23 families were recorded (Tab. 2). Two species – *Pelecopsis pavidus* (O. P.-Cambridge, 1872) (Linyphiidae) (det. R. Bosmans) and *Xysticus kaznakovi* Utochkin, 1968 (Thomisidae) (det. D. Logunov) – proved to be new for the European spider fauna. *Pelecopsis pavidus* was hitherto only known from its type locality in Palestine (Bosmans 1994). During the present study, one male was sampled in a grey dune habitat in the Nestos delta. *Xysticus kaznakovi* has been recorded in Central Asia (Marusik & Logunov 1990) and Turkey, where it was collected under stones and on the ground in grass (Demir et al. 2009). One male was caught in a dry and sparse vegetated habitat.

Twenty-one and thirty-eight species were new to East Macedonia and Thrace, respectively. In addition

to *Pelecopsis pavidus* and *Xysticus kaznakovi*, ten further species could be added to the Greek fauna for the first time:

Oedothorax retusus, *Pocadicnemis pumila* and *Stemonyphantes lineatus* are widespread across Europe (Nentwig et al. 2013) and inhabit a broad variety of habitats (Hänggi et al. 1995).

Sitticus saltator is also an element of the European fauna (Nentwig et al. 2013), but its occurrence seems to be restricted to dry habitats such as dry grassland, heathland and dunes (Bauchhenß 1995, Merckens 2002, Buchholz & Kreuels 2009, Buchholz & Schirmel 2011) and accordingly three females were found in a white dune of the Nestos delta.

Meioneta resslis (det. R. Bosmans) and *Thanatus coloradensis* (det. C. Muster) are high mountain species (Muster 2001, Nentwig et al. 2013). While the latter was found in meadows of the European mountains (Alps, Pyrenees, Carpathians, Caucasus) (Nentwig et al. 2013), *Meioneta resslis* was hitherto considered an endemic species of the Alps (Muster 2001) inhabiting alpine grass heaths and as far down as the valley (Thaler 1995, Muster 2001, Höfer et al. 2010). In the present study, *Thanatus coloradensis* was sampled in dry grasslands of the Falakron mountain while *Meioneta resslis* was found at the same habitat type in the Nestos canyon.

Philodromus albidus (det. C. Muster), which was sampled from rocks, is mainly distributed in Western and Central Europe (Nentwig et al. 2013, Platnick 2013) but was also recorded in Bulgaria (Lazarov 2007) and Turkey (Bayram et al. 2013).

Diaea livens has been found in Western, Central and Southern Europe (Lazarov 2007, Bayram et al. 2013, Nentwig et al. 2013) as well as in the Caucasus (Otto & Tramp 2011, Nentwig et al. 2013) but was also introduced into the USA (Platnick 2013). *Diaea livens* is arboreal (mainly oaks) (Nentwig et al. 2013) and accordingly this species was caught in dwarf-shrubs.

Heriaeus graminicola is distributed in Central, Eastern and South-Eastern Europe (Deltshev et al. 2004, Nentwig et al. 2013) and according to Hänggi et al. (1995) and Nentwig et al. (2013) it inhabits dense vegetated and humid habitats (e.g., reedy marsh). By contrast, a number of individuals were sampled in different and mostly dry habitats.

Synageles scutigera (det. D. Logunov) has been rarely recorded. According to Logunov & Marusik (2000) and Platnick (2013) it was only found in

Tab. 2: Species list (nomenclature follows Platnick 2013). Abbreviations: biogeogr = biogeographical type: Blk = Balkan, Ci-Me = Circum-Mediterranean, EaMe = East-Mediterranean, Eu = European, Gr = Greek, Tur = Turanian (species with western limits of distribution formed by the Italian and Balkan peninsulas, respectively, and ranging as far as Central Asia), Tur-Eu = European species whose ranges extend eastward to Central Asia, Tur-Me = Mediterranean species whose ranges extend eastward to Central Asia, Wi = widely distributed species (cosmopolitan, palaearctic, holarctic); Gr = Greece, Ma = East Macedonia, Th = Thrace (nr = new record, + = species already recorded, ; m/f = number of sampled males and females, respectively; habitat types: A = building, B = dry grassland, C = dry habitat with sparse vegetation, D = dwarf shrub, E = fallow land, F = floodplain forest, G = fringe, H = gravel bank, I = grey dune, J = humid meadow, K = meadow, L = *Pinus*-forest, M = pseudo maquis, N = reed, O = riparian strip, P = rocks, Q = salt meadow, R = sandy shore, S = semi-dry grassland, T = tall-forb vegetation, U = white dune.

species	biogeogr	Gr	Ma	Th	m/f	sampling location	habitat type
Scytodidae							
<i>Scytodes thoracica</i> (Latreille, 1802)	Wi	+	+	+	1/0	21	P
Pholcidae							
<i>Holocnemus pluchei</i> (Scopoli, 1763)	Eu	+	+	+	0/1	9	P
Dysderidae							
<i>Harpactea babori</i> (Nosek, 1905)	EaMe	+	+	.	1/0	4	F
Mimetidae							
<i>Mimetes laevigatus</i> (Keyserling, 1863)	Tur-Me	+	+	.	1/0	4	F
Eresidae							
<i>Eresus kollari</i> Rossi, 1846	Tur-Eu	+	+	+	5/0	2, 3, 7, 9	B
Oecobiidae							
<i>Oecobius maculatus</i> Simon, 1870	Tur-Me	+	+	nr	0/1	21	P
Uloboridae							
<i>Uloborus walckenaerius</i> Latreille, 1806	Wi	+	+	+	1/1	4	I
Theridiidae							
<i>Enoplognatha penelope</i> Hippa & Oksala, 1982	Blk	+	+	.	0/2	7	E
<i>Euryopsis episinoides</i> (Walckenaer, 1847)	Tur-Me	+	+	.	0/1	4	Q
<i>Euryopsis sexalbomaculata</i> (Lucas, 1846)	Ci-Me	+	+	.	3/0	6	M
<i>Kochiura aulica</i> (C. L. Koch, 1838)	Wi	+	+	.	1/0	7	M
<i>Latrodectus tredecimguttatus</i> (Rossi, 1790)	Tur-Me	+	+	+	1/0	4	I
<i>Paidiscura dromedaria</i> (Simon, 1880)	Wi	+	nr	.	0/2	4	U
<i>Phylloneta impressa</i> (L. Koch, 1881)	Wi	+	+	+	1/1	7	E
<i>Steatoda triangulosa</i> (Walckenaer, 1802)	Wi	+	+	+	0/1	21	A
Linyphiidae							
<i>Erigone atra</i> Blackwall, 1833	Wi	+	.	nr	1/0	12	A
<i>Erigone dentipalpis</i> (Wider, 1834)	Wi	+	+	.	1/0	4	Q
<i>Frontinellina frutetorum</i> (C. L. Koch, 1834)	Wi	+	+	+	0/7	4, 20	K, P
<i>Gnathonarium dentatum</i> (Wider, 1834)	Wi	+	+	.	0/1	7	N
<i>Gongylidium rufipes</i> (Linnaeus, 1758)	Wi	+	+	.	0/1	4	F
<i>Maso gallicus</i> Simon, 1894	Wi	+	+	.	0/1	4	K
<i>Maso sundevalli</i> (Westring, 1851)	Wi	+	+	.	7/0	4	F
<i>Mecopisthes peusi</i> Wunderlich, 1972	Eu	+	+	.	0/9	4, 9	K, R
<i>Meioneta fuscipalpa</i> (C. L. Koch, 1836)	Wi	+	+	nr	6/0	4, 9, 21	K, R, T
<i>Meioneta resslii</i> Wunderlich, 1973	Eu	nr	nr	.	1/0	9	B
<i>Metopobactrus prominulus</i> (O. P.-Cambridge, 1872)	Wi	+	+	.	0/1	4	J
<i>Oedothorax apicatus</i> (Blackwall, 1850)	Wi	+	+	.	1/3	7	N, S
<i>Oedothorax retusus</i> (Westring, 1851)	Wi	nr	nr	.	0/1	2	P
<i>Pelecopsis elongata</i> (Wider, 1834)	Eu	+	+	.	0/1	4	F
<i>Pelecopsis inedita</i> (O. P.-Cambridge, 1875)	Ci-Me	+	nr	.	0/2	4	F, I
<i>Pelecopsis pavidata</i> (O. P.-Cambridge, 1872)	Tur	nr	nr	.	1/0	4	I

species	biogeogr	Gr	Ma	Th	m/f	sampling location	habitat type
<i>Prinerigone vagans</i> (Audouin, 1826)	Wi	+	+	+	1/6	4, 6, 9, 15	F, K, M, Q, T
<i>Pocadicnemis juncea</i> Locket & Millidge, 1953	Wi	+	+	.	0/28	4	Q
<i>Pocadicnemis pumila</i> (Blackwall, 1841)	Wi	nr	nr	.	1/0	7	N
<i>Stemonyphantes lineatus</i> (Linnaeus, 1758)	Wi	nr	nr	.	0/1	4	Q
<i>Styloctetor romanus</i> (O. P.-Cambridge, 1872)	Wi	+	+	.	0/9	4	I
<i>Tenuiphantes tenuis</i> (Blackwall, 1852)	Wi	+	+	nr	0/1	20	C
<i>Trichoncus hackmani</i> Millidge, 1955	Eu	+	+	.	0/1	7	E
<i>Walckenaeria alticeps</i> (Denis, 1952)	Tur-Eu	+	+	.	0/1	4	F
<i>Walckenaeria vigilax</i> (Blackwall, 1853)	Wi	+	+	.	1/0	4	J
Tetragnathidae							
<i>Tetragnatha extensa</i> (Linnaeus, 1758)	Wi	+	+	+	1/0	20	O
<i>Tetragnatha montana</i> Simon, 1874	Wi	+	+	.	1/0	7	S
<i>Tetragnatha obtusa</i> C. L. Koch, 1837	Wi	+	+	nr	1/0	15	T
Araneidae							
<i>Araneus angulatus</i> Clerck, 1757	Wi	+	+	+	3/19	7	G, M, S
<i>Araniella cucurbitina</i> (Clerck, 1757)	Wi	+	+	+	0/2	3	K
<i>Araniella opisthographa</i> (Kulczyński, 1905)	Tur-Eu	+	+	+	2/4	7, 19, 20	H, M, O
<i>Argiope bruennichi</i> (Scopoli, 1772)	Wi	+	+	+	8/9	7	E, G, M, N, S
<i>Argiope lobata</i> (Pallas, 1772)	Wi	+	+	+	0/3	17	K
<i>Cyclosa sierrae</i> Simon, 1870	Tur-Eu	+	nr	+	0/12	7, 20, 21	K, L, M
<i>Gibbaranea bituberculata</i> (Walckenaer, 1802)	Wi	+	+	+	0/3	7, 20	B, C
<i>Hypsosinga alborivittata</i> (Westring, 1851)	Wi	+	+	+	0/4	6, 7	E, P, T
<i>Hypsosinga pygmaea</i> (Sundevall, 1831)	Wi	+	+	.	0/1	7	S
<i>Larinoides cornutus</i> (Clerck, 1757)	Wi	+	+	nr	1/9	4, 7, 16	E, I, J, K, N, S
<i>Mangora acalypha</i> (Walckenaer, 1802)	Wi	+	+	+	8/46	7, 10, 20, 21	B, C, E, G, K, M, N, O, S
<i>Neoscona adianta</i> (Walckenaer, 1802)	Wi	+	+	+	29/76	7, 16, 18	E, G, J, K, M, N, S
Lycosidae							
<i>Alopecosa albofasciata</i> (Brullé, 1832)	Tur-Me	+	+	+	6/8	7, 9, 18, 19, 20, 21	B, E, H, K, L, P
<i>Alopecosa cuneata</i> (Clerck, 1757)	Wi	+	+	+	0/2	1	B
<i>Arctosa cinerea</i> (Fabricius, 1777)	Wi	+	+	+	2/2	5, 7, 20	O, R, U
<i>Arctosa leopardus</i> (Sundevall, 1833)	Wi	+	+	+	3/0	7	J, N
<i>Aulonia kratochvili</i> Dunin, Buchar & Absolon, 1986	Tur-Me	+	+	+	1/0	7	J
<i>Geolycosa vultuosa</i> (C. L. Koch, 1838)	Tur-Me	+	+	+	0/10	3, 7, 9	B, S
<i>Pardosa agricola</i> (Thorell, 1856)	Tur-Eu	+	+	nr	1/4	20	K
<i>Pardosa atomaria</i> (C. L. Koch, 1847)	Blk	+	+	+	0/2	20	O
<i>Pardosa blanda</i> (C. L. Koch, 1833)	Wi	+	+	.	3/3	1	B
<i>Pardosa cribrata</i> Simon, 1876	Ci-Me	+	+	.	4/3	7	J, N
<i>Pardosa hortensis</i> (Thorell, 1872)	Wi	+	+	+	0/5	7, 10, 20	B, K
<i>Pardosa monticola</i> (Clerck, 1757)	Wi	+	+	.	0/1	1	B
<i>Pardosa paludicola</i> (Clerck, 1757)	Wi	+	+	.	1/1	1, 7	J, S
<i>Pardosa prativaga</i> (L. Koch, 1870)	Tur-Eu	+	+	.	1/2	7	J, N
<i>Pardosa proxima</i> (C. L. Koch, 1847)	Wi	+	+	+	2/0	7	J
<i>Pirata latitans</i> (Blackwall, 1841)	Tur-Eu	+	+	+	0/2	4	F
<i>Trochosa ruricola</i> (De Geer, 1778)	Wi	+	+	+	3/2	7	J, N
<i>Xerolycosa miniata</i> (C. L. Koch, 1834)	Wi	+	+	nr	0/1	20	K

species	biogeogr	Gr	Ma	Th	m/f	sampling location	habitat type
Pisauridae							
<i>Pisaura mirabilis</i> (Clerck, 1757)	Wi	+	+	+	0/13	7, 9, 20, 21	B, E, J, K, P, S
<i>Pisaura novicia</i> (L. Koch, 1878)	Tur-Me	+	nr	.	0/1	3	K
Oxyopidae							
<i>Oxyopes heterophthalmus</i> (Latreille, 1804)	Wi	+	+	+	4/8	3, 7, 20, 21	E, G, J, K, R, T
<i>Oxyopes lineatus</i> Latreille, 1806	Wi	+	+	+	6/6	7, 9, 20, 21	B, C, K, R, T
<i>Oxyopes nigripalpis</i> Kulczyński, 1891	Ci-Me	+	+	nr	5/0	21	T
Agelenidae							
<i>Agelena orientalis</i> C. L. Koch, 1837	Tur-Me	+	+	.	0/1	7	M
<i>Maimuna vestita</i> (C. L. Koch, 1841)	EaMe	+	+	+	0/4	6, 21	L, M, P
<i>Tegenaria angustipalpis</i> Levy, 1996	EaMe	+	+	.	0/1	6	P
<i>Tegenaria parietina</i> (Fourcroy, 1785)	Wi	+	+	nr	0/1	13	A
Dictynidae							
<i>Devade indisticta</i> (O. P.-Cambridge, 1872)	Ci-Me	+	nr	.		4	Q
<i>Dictyna arundinacea</i> (Linnaeus, 1758)	Wi	+	+	+	12/22	7, 20	E, G, J, N, O, R, S
Titanoecidae							
<i>Nurscia albomaculata</i> (Lucas, 1846)	Tur-Eu	+	+	.	0/1	6	P
Zodariidae							
<i>Zodarion blagoevi</i> Bosmans 2009	Blk	+	+	.	10/0	7	R
<i>Zodarion epirense</i> Brignoli, 1984	Blk	+	+	.	0/4	7	G, P
<i>Zodarion frenatum</i> Simon, 1884	EaMe	+	+	.	2/12	4	B, K, P, Q, U
<i>Zodarion granulatum</i> Kulczyński, 1908	EaMe	+	nr	.	1/0	7	G
<i>Zodarion hauseri</i> Brignoli, 1984	Gr	+	+	.	1/0	7	R
<i>Zodarion morosum</i> Denis, 1935	Eu	+	+	.	2/0	4, 7	E
<i>Zodarion pirini</i> Drensky, 1921	Blk	+	nr	.	3/0	4	K, R
<i>Zodarion thoni</i> Nosek, 1905	Tur-Eu	+	nr	.	4/0	4, 7	B, U
Gnaphosidae							
<i>Callilepis cretica</i> (Roewer, 1928)	Tur-Me	+	+	+	1/0	19	H
<i>Drassodes lapidosus</i> (Walckenaer, 1802)	Wi	+	+	+	1/1	8, 19	K, P
<i>Drassodes lutescens</i> (C. L. Koch, 1839)	Tur-Me	+	+	nr	0/4	6, 19, 20, 21	C, P
<i>Gnaphosa lucifuga</i> (Walckenaer, 1802)	Wi	+	+	+	2/4	4, 20	O, Q
<i>Gnaphosa lugubris</i> (C. L. Koch, 1839)	Tur-Eu	+	+	.	0/1	1	B
<i>Haplodrassus dalmatensis</i> (L. Koch, 1866)	Wi	+	+	nr	1/0	14	A
<i>Haplodrassus signifer</i> (C. L. Koch, 1839)	Wi	+	+	+	0/1	21	A
<i>Nomisia exornata</i> (C. L. Koch, 1839)	Tur-Eu	+	+	nr	7/8	6, 9, 19, 20, 21	B, C, H, L, M, S
<i>Nomisia ripariensis</i> (O. P.-Cambridge, 1872)	Tur	+	+	+	4/0	4, 6, 18	K, P, S
<i>Trachyzelotes barbatus</i> (L. Koch, 1866)	Tur-Me	+	+	.	0/1	9	B, P
<i>Trachyzelotes lyonneti</i> (Audouin, 1826)	Tur-Me	+	+	.	0/1	4	Q
<i>Trachyzelotes malkini</i> Platnick & Murphy, 1984	Eu	+	+	.	2/1	4, 7	B, K, S
<i>Zelotes argoliensis</i> (C. L. Koch, 1839)	Blk	+	+	+	0/1	9	R
<i>Zelotes caucasi</i> (L. Koch, 1866)	Tur-Eu	+	+	nr	3/0	21	P
<i>Zelotes cingarus</i> (O. P.-Cambridge, 1874)	EaMe	+	+	nr	0/1	21	P
<i>Zelotes tenuis</i> (L. Koch, 1866)	Ci-Me	+	+	.	1/1	4	I, Q

species	biogeogr	Gr	Ma	Th	m/f	sampling location	habitat type
Sparassidae							
<i>Micrommata ligurina</i> (C. L. Koch, 1845)	Tur-Me	+	+	+	0/1	16	K
Philodromidae							
<i>Philodromus albidus</i> Kulczyński 1911	Eu	nr	nr	.	0/1	8	P
<i>Philodromus glaucinus</i> Simon, 1870	Ci-Me	+	+	.	0/1	7	T
<i>Philodromus lunatus</i> Muster & Thaler, 2004	EaMe	+	+	nr	2/1	7, 20, 21	C, M, P
<i>Philodromus pulchellus</i> Lucas, 1846	Ci-Me	+	+	.	0/1	4	E, S
<i>Thanatus atratus</i> Simon, 1875	Wi	+	+	nr	10/11	4, 6, 7, 10, 20	B, E, N, O, P, S
<i>Thanatus coloradensis</i> Keyserling, 1880	Wi	nr	nr	.	1/2	1	B
<i>Thanatus pictus</i> L. Koch, 1881	Wi	+	nr	nr	3/0	4, 16	K, U
<i>Thanatus vulgaris</i> Simon, 1870	Wi	+	+	.	0/3	4, 7	S, U
<i>Tibellus oblongus</i> (Walckenaer, 1802)	Wi	+	+	nr	8/20	7, 9	B, F, G, K, N, O, S
Thomisidae							
<i>Diaea livens</i> Simon, 1876	Tur-Eu	nr	nr	.	1/0	8	D
<i>Heriapus graminicola</i> (Doleschall, 1852)	Tur-Eu	nr	nr	nr	8/0	7, 20	C, G, K, S
<i>Heriapus setiger</i> (O. P.-Cambridge, 1872)	Wi	+	+	nr	2/0	4, 21	B, T
<i>Misumena vatia</i> (Clerck, 1757)	Wi	+	+	nr	0/4	7, 21	S, T
<i>Monaeses israeliensis</i> Levy, 1973	Tur-Me	+	+	.	1/0	7	G
<i>Ozyptila confluens</i> (C. L. Koch, 1845)	EaMe	+	+	.	1/0	4	A
<i>Runcinia grammica</i> (C. L. Koch, 1837)	Wi	+	+	+	20/1	7, 21	E, G, N, S, T
<i>Synema globosum</i> (Fabricius, 1775)	Wi	+	+	+	5/3	15, 21	K, T
<i>Synema plorator</i> (O. P.-Cambridge, 1872)	Tur-Me	+	+	.	0/1	8	P
<i>Thomisus onustus</i> Walckenaer, 1805	Wi	+	+	+	8/0	9, 20, 21	B, K, P, T
<i>Tmarus piger</i> (Walckenaer, 1802)	Wi	+	+	+	2/0	4, 7	F, R
<i>Xysticus caperatus</i> Simon, 1875	Ci-Me	+	+	.	1/0	6	M, P
<i>Xysticus kaznakovi</i> Utochkin, 1968	Tur	nr	nr	.	1/0	4	C
<i>Xysticus kochi</i> Thorell, 1872	Wi	+	+	+	1/3	7, 9	B, E, G, J
<i>Xysticus laetus</i> Thorell, 1875	Tur-Me	+	+	nr	4/1	4, 21	F, T
<i>Xysticus lanius</i> C. L. Koch, 1835	Wi	+	.	+	0/2	20	C, O
<i>Xysticus tristrami</i> (O. P.-Cambridge, 1872)	Tur-Me	+	.	nr	3/1	21	P
Salticidae							
<i>Aelurillus luctuosus</i> (Lucas, 1846)	Tur-Me	+	.	nr	0/1	21	P
<i>Bianor albobimaculatus</i> (Lucas, 1846)	Tur-Me	+	+	+	0/1	9	R
<i>Chalcoscirtus nigrinus</i> (Thorell, 1875)	Wi	+	+	.	1/0	4	K
<i>Cyrtus algerina</i> (Lucas, 1846)	Wi	+	.	nr	1/1	9, 19	B, P
<i>Evarcha arcuata</i> (Clerck, 1757)	Wi	+	+	+	3/2	7	N, S
<i>Evarcha jucunda</i> (Lucas, 1846)	Ci-Me	+	+	nr	5/0	9, 19, 21	B, H, L, P
<i>Heliophanus equester</i> L. Koch, 1867	Tur-Me	+	+	+	1/5	7, 16, 20	E, N, S, T
<i>Heliophanus flavipes</i> (Hahn, 1832)	Wi	+	+	+	1/0	7	N
<i>Heliophanus kochii</i> Simon, 1868	Wi	+	+	+	0/1	20	K
<i>Heliophanus melinus</i> L. Koch, 1867	Wi	+	+	+	8/2	9, 10, 19, 20, 21	B, C, P
<i>Heliophanus tribulosus</i> Simon, 1868	Tur-Eu	+	+	.	1/0	6	M
<i>Icius hamatus</i> (C. L. Koch, 1846)	Wi	+	+	nr	1/1	18	K
<i>Macaroeis nidicolens</i> (Walckenaer, 1802)	Tur-Eu	+	+	nr	2/0	20, 21	C, L
<i>Menemerus semilimbatus</i> (Hahn, 1829)	Wi	+	+	nr	3/2	2, 4, 6, 15	P, T, U
<i>Menemerus taeniatus</i> (L. Koch, 1867)	Tur-Me	+	+	nr	0/1	18	K
<i>Mogrus neglectus</i> (Simon, 1868)	Tur-Me	+	+	nr	2/4	4, 7, 9	B, G, P, S, U
<i>Neaetha membrosa</i> (Simon, 1868)	Eu	+	+	.	1/0	9	B, P

species	biogeogr	Gr	Ma	Th	m/f	sampling location	habitat type
<i>Pellenes brevis</i> (Simon, 1868)	Eu	+	+	.	1/0	7	R
<i>Pellenes diagonalis</i> (Simon, 1868)	EaMe	+	+	.	0/5	6, 7, 8	B, P, S
<i>Pellenes flavipalpis</i> (Lucas, 1853)	EaMe	+	.	nr	1/0	19	P
<i>Pellenes geniculatus</i> (Simon, 1868)	Wi	+	.	nr	2/4	9, 19, 20	B, H, K, P
<i>Pellenes nigrociliatus</i> (Simon, 1875)	Wi	+	+	+	1/0	9	R
<i>Pellenes seriatus</i> (Thorell, 1875)	Tur-Me	+	+	.	0/3	7	E
<i>Philaeus chrysops</i> (Poda, 1761)	Wi	+	+	+	9/1	3, 6, 8, 9, 19, 21	B, H, K, P
<i>Phintella castrisiana</i> (Grube, 1861)	Wi	+	+	.	1/0	4	F
<i>Pblegra fasciata</i> (Hahn, 1826)	Wi	+	+	+	4/2	3, 7, 9, 21	E, L, N, P
<i>Pseudeuophrys obsoleta</i> (Simon, 1868)	Wi	+	+	+	1/0	7	M
<i>Pseudiculus picaceus</i> (Simon, 1868)	Tur-Me	+	.	nr	1/0	9	P
<i>Saitis tauricus</i> Kulczyński, 1905	Tur-Me	+	+	nr	1/2	6, 21	A, P
<i>Salticus mutabilis</i> Lucas, 1846	Wi	+	+	nr	1/0	18	K
<i>Salticus noordami</i> Metzner, 1999	Gr	+	.	nr	1/0	9	B, P
<i>Sitticus atricapillus</i> (Simon, 1882)	Eu	+	+	.	0/1	1	B
<i>Sitticus saltator</i> (O. P.-Cambridge, 1868)	Wi	nr	nr	.	0/3	4	U
<i>Synageles dalmaticus</i> (Keyserling, 1863)	Ci-Me	+	+	.	3/0	5, 6	A, P, U
<i>Synageles scutiger</i> Prószyński, 1979	Tur-Eu	nr	nr	.	0/1	4	U

Ukraine and Azerbaijan. One female was caught in a white dune of the Nestos delta.

Knowledge of the distribution patterns and ecology of several of the species caught is still poor, and more faunistic and especially ecological studies are needed to gain a better understanding of the Greek but also of the Eastern Mediterranean spider fauna. However, based on previous work (Bosmans & Chatzaki 2005, Bosmans et al. 2009, Van Keer et al. 2010, Schröder et al. 2011), together with the present study, the Greek spider fauna now includes 1,108 species.

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